DIFFUSION OF INNOVATIONS

Third Edition

Everett M. Rogers

FP

THE FREE PRESS
A Division of Macmillan Publishing Co., Inc.
NEW YORK

Collier Macmillan Publishers
LONDON

The Free Press
A Division of Macmillan Publishing Co., Inc.
866 Third Avenue, New York, N. Y. 10022

Collier Macmillan Canada, Inc.

Library of Congress Catalog Card Number: 82-70998

Printed in the United States of America

printing number

6 7 8 9 10

Library of Congress Cataloging in Publication Data

Rogers, Everett M.
Diffusion of innovations.

Rev. ed. of: Communication of innovations. 2nd ed. 1971.
Bibliography: p.
Includes indexes.
1. Diffusion of innovations. 2. Diffusion of innovations—Study and teaching—History. I. Title.
HM101.R57 1983 303.4'84 82-70998
ISBN 0-02-926650-5 AACR2

The first edition by Everett M. Rogers was published as *Diffusion of Innovations;* the second edition of this book, by Everett M. Rogers with F. Floyd Shoemaker, was published as *Communication of Innovations: A Cross-Cultural Approach.*

Contents

Contents

list of Case Illustrations

Preface

THE FIRST EDITION OF THIS *BOOK, Diffusion of Innovations,* was published in 1962. At the time, there were 405 publications about this topic available. The second edition and revision, *Communication of Innovations: A Cross-Cultural Approach* (co-authored with F. Floyd Shoemaker), was published in 1971, nine years later. By then the number of diffusion publications had almost quadrupled to about 1,500, of which approximately 1,200 were empirical research reports, and the other 300 were bibliographies, syntheses, theoretical writings, and other types of nonempirical publications.

At present, 12 years later, the total number of diffusion publications has more than doubled again, to 3,085. And the number of empirical diffusion research reports has increased from 1,500 to 2,297. I think there is almost no other field of behavior science research that represents more effort by more scholars in more nations.

Because of this vast increase in the foundation of diffusion research on which the present book is based, it is both (1) a revision of the theoretical framework, and the research evidence supporting this model of diffusion, and (2) a new intellectual venture, in the sense that new concepts and new theoretical viewpoints are introduced. I estimate that this book represents about equally (1) a continuity with my two previous books on diffusion, and (2) differences and improvements in the basic framework. So the reader can regard the present book as the third volume in a three-volume set on the diffusion of innovations. The stream of diffusion scholarship over the past forty years or so represents both similarities and differences, continuities and discontinuities, and so must my three books, each published approximately a decade apart. By no means, however, do I seek only to synthesize the important findings from past research; I also strive herein to criticize this work (including my own), and to lay out directions for the future that are different from the recent past.

I have titled the present book *Diffusion of Innovations* to identify it with the forty-year sequential tradition of diffusion studies marked by my 1962 book of the same title. In any event, most people refer to

this research field and its applications as the "diffusion of innovations." By choosing a title somewhat different from my second book, I can help avoid confusion of these two volumes.

Most diffusion studies prior to 1962 were conducted in the United States and Europe. In the period between the first and second editions of my diffusion book, during the 1960s, an explosion occurred in the number of diffusion investigations that were conducted in the developing nations of Latin America, Africa, and Asia. It was realized that the classical diffusion model could be usefully applied to the process of socioeconomic development. In fact, the diffusion approach was a natural framework in which to evaluate the impact of development programs in agriculture, family planning, public health, and nutrition. But in studying the diffusion of innovations in developing nations, we gradually realized that certain limitations existed in the diffusion framework. In some cases, development programs outran the diffusion model on which they were originally based. One intellectual outcome was certain modifications that have been made in the classical diffusion model. As a result, the diffusion paradigm that is presented in this book is less culture-bound than in my previous books. And the study of diffusion has today become worldwide.

During the 1970s, I have also seen important changes, modifications, and improvements made in the diffusion model in the United States and other industrialized nations. One important type of change has been to view the diffusion process in a wider scope and to understand that diffusion is one part of a larger process which begins with a perceived problem or need, through research and development on a possible solution, the decision by a change agency that this innovation should be diffused, and then its diffusion (leading to certain consequences). Such a broader view of the innovation-development process recognizes that many decisions and activities must happen before the beginning of the diffusion of an innovation; often diffusion cannot be very completely understood if these previous phases of the total process are ignored. Chapter 4 of the present book deals with this issue of where innovations come from, and how their origins affect their diffusion.

Another important intellectual change of the past decade, reflected in Chapter 10, is the greatly increased interest in the innovation process in organizations. Such organizational decisions are different in important ways from innovation decisions by individuals, we now realize.

The present book also differs from its two predecessors in that it

reflects a much more critical stance. During the past twenty years or so, diffusion research has grown to be widely recognized, applied, and admired, but it has also been subjected to constructive and destructive criticism. This criticism is due in large part to the stereotyped and limited ways in which most diffusion scholars have come to define the scope and method of their field of study. Once diffusion researchers came to represent an "invisible college,"* they began to limit unnecessarily the ways in which they went about studying the diffusion of innovations. Such standardization of approaches has, especially in the past decade, begun to constrain the intellectual progress of diffusion research.

Perhaps the diffusion case is rather similar to that of persuasion research, another important subfield of communication research. Two of the leading persuasion scholars, Professors Gerald R. Miller and Michael Burgoon (1978, p. 31), recently described the myopic view of the social-influence process held by most persuasion scholars: "Students of persuasion may have fallen captive to the limits imposed by their own operational definitions of the area" [sentence was italicized in the original]. This self-criticism applies to diffusion researchers as well, because, in fact, many diffusion scholars have conceptualized the diffusion process as one-way persuasion. As such, they also may be subject to the four shortcomings of persuasion research listed by Miller and Burgoon (1978, pp. 31-35):

1. Persuasion (and diffusion) are seen as a linear, unidirectional communication activity. An active source constructs messages in order to influence the attitudes and/or behaviors of passive receivers. Cause resides in the source, and effect in the receiver.

2. Persuasion (and diffusion) are considered as a one-to-many communication activity. This view is inconsistent with more recent conceptions of persuasion: "Persuasion is not something one person does to another but something he or she does *with* another" (Reardon, 1981, p. 25).

3. Persuasion (and diffusion) scholars are preoccupied with an action-centered and issue-centered communication activity, such as selling products, actions, or policies. Largely ignored is the fact that an important part of persuasion/diffusion is selling *oneself and,* perhaps, other persons. It should be realized that one objective of certain diffusion activities is to enhance one's personal credibility in the eyes of others (as we detail in Chapters 8 and 9).

An *invisible college* is an informal network of researchers who form around an intellectual paradigm to study a common topic (Price, 1963; Kuhn, 1970; Crane, 1972).

4. Persuasion (and diffusion) researchers often give allegiance to the view that their dependent variable is to change attitudes rather than overt behavior. Diffusion researchers have been more oriented to the dependent variable of adoption (a *decision* to use and implement a new idea), than to actual *implementation* itself (or to studying the consequences of innovation).

Most past diffusion studies have been based upon a linear model of communication, defined as the process by which messages are transferred from a source to a receiver. Such a one-way view of human communication describes certain types of communication; many kinds of diffusion do indeed consist of one individual, such as a change agent, informing a potential adopter about a new idea. But other types of diffusion are more accurately described by a convergence model, in which communication is defined as a process in which the participants create and share information with one another to reach a mutual understanding (Rogers and Kincaid, 1981, p. 63).

In the present book we seek to show the improved understanding that can often be achieved by conceptualizing certain kinds of diffusion in light of this convergence model. This emphasis on diffusion as information exchange among participants in a communication process is found particularly in our Chapter 8 on diffusion networks.

Conceptually, the present book makes use of the important concepts of uncertainty and information. *Uncertainty* is the degree to which a number of alternatives are perceived with respect to the occurrence of an event and the relative probabilities of these alternatives. Uncertainty implies a lack of predictability of the future. It motivates an individual to seek information. *Information* is a difference in matter-energy that affects uncertainty in a situation where a choice exists among a set of alternatives (Rogers and Kincaid, 1981, p. 64). The concept of information is a favorite in the field of communication research, and in fact the field really began to grow as an intellectual enterprise once Claude Shannon and Warren Weaver (1949) had proposed a theory of communication that was organized around the notion of information.

One kind of uncertainty is generated by an *innovation,* defined as an idea, practice, or object that is perceived as new by an individual or another unit of adoption. An innovation presents an individual or an organization with a new alternative or alternatives, with new means of solving problems. But the probabilities of the new alternatives being superior to previous practice are not exactly known by the individual problem solvers. Thus, they are motivated to seek further information

about the innovation in order to cope with the uncertainty that it creates.

So the present book is cast in a theoretical framework involving the concepts of information and uncertainty. Information about innovations is often sought from near-peers, especially information about their subjective evaluations of the innovation. This information exchange about a new idea occurs through a convergence process involving interpersonal networks. The diffusion of innovations, thus, is essentially a social process in which subjectively perceived information about a new idea is communicated.

The general field of communication research has not been characterized by much "weed pulling," that is, the criticism of our scientific activities so that the field's findings and fallacies can be publicly understood (Siebold, 1979). Thus, it may be a healthy turn of events that, beginning in the early 1970s, criticisms of the diffusion framework began to appear. Of course, it would be a mistake to become so fond of weed pulling that the entire garden is destroyed (Reardon, 1981, p. 261).

Throughout the present book we seek to represent a healthily critical stance. We do not just need more-of-the-same diffusion research. The challenge for diffusion scholars of the future is to move beyond the proven methods and models of the past, to recognize their shortcomings and limitations, and to broaden their conceptions of the diffusion of innovations. We offer this book as one step toward this goal.

Stanford, California — Everett M. Rogers

CHAPTER 1

Elements of Diffusion

To get the bad customs of a country changed and new ones, though better, introduced, it is necessary first to remove the prejudices of the people, enlighten their ignorance, and convince them that their interests will be promoted by the proposed changes; and this is not the work of a day.

Benjamin Franklin (1781)

There is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage than the creation of a new order of things. . . . Whenever his enemies have occasion to attack the innovator they do so with the passion of partisans, while the others defend him sluggishly so that the innovator and his party alike are vulnerable.

Niccolo Machiavelli
The Prince (1513)

ONE REASON WHY THERE is so MUCH INTEREST in the diffusion of innovations is because getting a new idea adopted, even when it has obvious advantages, is often very difficult. There is a wide gap in many fields, between what is known and what is actually put into use. Many innovations require a lengthy period, often of some years, from the time when they become available to the time when they are widely adopted. Therefore, a common problem for many individuals and organizations is how to speed up the rate of diffusion of an innovation.

The following case illustration provides insight into some common difficulties facing programs of diffusion.

Water Boiling in a Peruvian Village: A Diffusion Campaign that Failed*

The public health service in Peru attempts to introduce innovations to villagers to improve their health and lengthen their lives. This change agency

This case illustration is adapted from Wellin (1955, pp. 71-103), and is used by permission.

enjoys a reputation for efficiency throughout Latin America. It encourages people to install latrines, to burn garbage daily, to control house flies, to report cases of infectious diseases, and to boil drinking water. These innovations involve major changes in thinking and behavior for Peruvian villagers, who do not understand how sanitation is related to illness.

Water boiling is an important health practice for villagers and urban poor in Peru. Unless they boil their drinking water, patients who are cured of infectious diseases in village medical clinics often return within a month to be treated again for the same disease.

A two-year water-boiling campaign conducted in Los Molinos, a peasant village of 200 families in the coastal region of Peru, persuaded only Steven housewives to boil water. From the viewpoint of the public health agency, the local health worker, Nelida, had a simple task: to persuade the housewives of Los Molinos to add water boiling to their pattern of daily behavior. Even with the aid of a medical doctor, who gave public talks on water boiling, and fifteen village housewives who were already boiling water before the campaign, Nelida's diffusion program failed. To understand why, we need to take a closer look at the culture, the local environment, and the individuals in Los Molinos.

THE VILLAGE OF Los MOLINOS. Most residents of Los Molinos are peasants who work as field hands on local plantations. Water is carried by can, pail, gourd, or cask. Children are the usual water carriers; it is not considered appropriate for adult men to carry water, and they seldom do. The three sources of water in Los Molinos include a seasonal irrigation ditch close to the village, a spring more than a mile away from the village, and a public well whose water the villagers dislike. All three are subject to pollution at all times and show contamination whenever tested. Of the three sources, the irrigation ditch is most commonly used. It is closer to most homes, it has the advantage of being running water rather than stagnant, and the villagers like its taste.

Although it is not feasible for the village to install a sanitary water system, the incidence of typhoid and other water-borne diseases could be reduced by boiling the water before consumption. During her two-year residence in Los Molinos, Nelida made several visits to every home in the village but devoted especially intensive efforts to twenty-one families. She visited each of these selected families between fifteen and twenty-five times; eleven of these families now boil their water regularly.

What kinds of persons do these numbers represent? We describe three village housewives—one who boils water to obey custom, one who was persuaded to boil water by the health worker, and one of the many who rejected the innovation—in order to add further insight into the process of diffusion.

Mrs. A: Custom-Oriented Adopter. Mrs. A is about forty and suffers from sinus infection. The Los Molinos villagers call her a "sickly one." Each morning Mrs. A boils a potful of water and uses it throughout the day. She has no understanding of germ theory, as explained by Nelida; her motivation for water boiling is a complex local custom of "hot" and "cold" distinctions. The basic principle of this belief system is that all foods, liquids, medicines, and other objects are inherently hot or cold, quite apart from their actual temperature. In essence hot-cold distinctions serve as a series of avoidances and approaches in such behavior as pregnancy, child rearing, and the health-illness system.

Boiled water and illness are closely linked in the folkways of Los Molinos; by custom, only the ill use cooked, or "hot" water. Once an individual becomes ill, it is unthinkable for him to eat pork (very cold) or to drink brandy (very hot). Extremes of hot and cold must be avoided by the sick; therefore, raw water, which is perceived to be very cold, must be boiled to overcome the extreme temperature.

Villagers learn from childhood to dislike boiled water. Most can tolerate cooked water only if flavoring, such as sugar, cinnamon, lemon, or herbs, is added. Mrs. A likes a dash of cinnamon in her drinking water. The village belief system involves no notion of bacteriological contamination of water. By tradition, boiling is aimed at eliminating the innate "cold" quality of unboiled water, not the harmful bacteria. Mrs. A drinks boiled water in obedience to local custom, because she is ill.

Mrs. B: Persuaded Adopter. The B family came to Los Molinos a generation ago, but they are still strongly oriented toward their birthplace high in the Andes Mountains. Mrs. B worries about lowland diseases that she feels infest the village. It is partly because of this anxiety that the change agent, Nelida, was able to convince Mrs. B to boil water.

Nelida is a friendly authority to Mrs. B (rather than a "dirt inspector," as she is seen by most other housewives), who imparts knowledge and brings protection. Mrs. B not only boils water but also has installed a latrine and has sent her youngest child to the health center for a check-up.

Mrs. B is marked as an outsider in the community by her highland hairdo and stumbling Spanish. She will never achieve more than marginal social acceptance in the village. Because the community is not an important reference group to her, Mrs. B deviates from village norms on health innovations. With nothing to lose socially, Mrs. B gains in personal security by heeding Nelida's advice. Mrs. B's practice of boiling water has no effect on her marginal status. She is grateful to Nelida for teaching her how to neutralize the danger of contaminated water, a lowland peril as she perceives it.

Mrs. C: Rejector. This housewife represents the majority of Los Molinos families who are not persuaded by the efforts of the change agent during the two-year health campaign. In spite of Nelida's repeated explanations, Mrs. C does not understand germ theory. How, she argues, can microbes survive in water that would drown people? Are they fish? If germs are so small that they cannot be seen or felt, how can they hurt a grown person? There are enough real threats in the world to worry about—poverty and

hunger—without bothering about tiny animals one cannot see, hear, touch, or smell. Mrs. C's allegiance to traditional customs is at odds with the boiling of water. A firm believer in the hot-cold superstition, she feels that only the sick must drink boiled water.

UNDERSTANDING WHY THE DIFFUSION OF WATER BOILING FAILED. This intensive two-year campaign by a public health worker in a Peruvian village of 200 families, aimed at persuading housewives to boil drinking water, was largely unsuccessful. Nelida was able to encourage only about 5 percent of the population, eleven families, to adopt the innovation. In contrast, change agents in other Peruvian villages were able to convince 15 to 20 percent of the housewives. Reasons for the relative failure of the diffusion campaign in Los Molinos can be traced partly to the cultural beliefs of the villagers. Local tradition links hot foods with illness. Boiling water makes it less "cold," and hence, appropriate only for the sick. But if a person is not ill, he is prohibited by village norms from drinking boiled water. Only the individuals who are least integrated into local networks risk defying community norms on water boiling. An important factor affecting the adoption rate of any innovation is its compatibility with the values, beliefs, and past experiences of the social system. Nelida and her superiors in the public health agency should have understood the hot-cold belief system, as it is found throughout Peru (and, in fact, in most nations of Latin America, Africa, and Asia).

Nelida's failure demonstrates the importance of interpersonal networks in the adoption and rejection of an innovation. Socially an outsider, Mrs. B was marginal to the Los Molinos community, although she had lived there for years. Nelida was a more important referent for Mrs. B than were her neighbors, who shunned her. Anxious to secure social acceptance from the higher-status Nelida, Mrs. B adopted water boiling, not because she understood the correct health reasons, but because she wanted to obtain Nelida's approval. Thus we see that the diffusion of innovations is often a social process, as well as a technical matter.

Nelida worked with the wrong housewives if she wanted to launch a self-generating diffusion process in Los Molinos. She concentrated her efforts on village women like Mrs. A and Mrs. B. Unfortunately, they were perceived as a sickly one and a social outsider and were not respected as social models of water-boiling behavior by the other women. The village opinion leaders, who could have activated local networks to spread the innovation, were ignored by Nelida.

How potential adopters view the change agent affects their willingness to adopt his or her ideas. In Los Molinos, Nelida was perceived differently by lower- and middle-status housewives. Most poor families saw the health worker as a "snooper" sent to Los Molinos to pry for dirt and to press already harassed housewives into keeping cleaner homes. Because the lower-status housewives had less free time, they were unlikely to initiate visits with

Nelida about water boiling. Their contacts outside the community were limited, and as a result, they saw the technically proficient Nelida with eyes bound by the social horizons and traditional beliefs of Los Molinos. They distrusted this outsider, whom they perceived as a social stranger. Nelida, who was middle class by Los Molinos standards, was able to secure more positive results from housewives whose socioeconomic level and cultural background were more similar to hers. This tendency for more effective communication to occur with those who are more similar to change agents occurs in most diffusion campaigns.

In general Nelida was too "innovation-oriented" and not "client-oriented" enough. Unable to put herself in the role of the village housewives, her attempts at persuasion failed to reach her clients because the message was not suited to their needs. Nelida did not begin where the villagers were; instead she talked to them about germ theory, which they could not (and probably did not need to) understand.

We have cited only some of the factors that produced the diffusion failure with which Nelida is charged. It will be easier to understand the water-boiling case once the remainder of this book has been read. We shall return to discuss lessons learned from the Los Molinos case in future chapters.

What Is Diffusion?

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas. *Communication* is a process in which participants create and share information with one another in order to reach a mutual understanding. This definition implies that communication is a process of convergence (or divergence) as two or more individuals exchange information in order to move toward each other (or apart) in the meanings that they ascribe to certain events. We think of communication as a two-way process of convergence, rather than as a one-way, linear act in which one individual seeks to transfer a message to another (Rogers and Kincaid, 1981). Such a simple conception of human communication may accurately describe certain communication acts or events involved in diffusion, such as when a change agent seeks to persuade a client to adopt an innovation. But when we look at what came before such an event, and at what follows, we often realize that such an event is only one part of a total process in which in-

formation is exchanged between the two individuals. For example, the client may come to the change agent with a problem or need, and the innovation is recommended as a possible solution. And if we look at the change agent-client interaction in a broader context, we may see that their interaction continues through several cycles, and is indeed a process of information exchange.

So diffusion is a special type of communication, in which the messages are concerned with a new idea. It is this newness of the idea in the message content of communication that gives diffusion its special character. The newness means that some degree of uncertainty is involved.

Uncertainty is the degree to which a number of alternatives are perceived with respect to the occurrence of an event and the relative probability of these alternatives. Uncertainty implies a lack of predictability, of structure, of information. In fact, information represents one of the main means of reducing uncertainty. *Information* is a difference in matter-energy that affects uncertainty in a situation where a choice exists among a set of alternatives (Rogers and Kincaid, 1981, p. 64).* As we show in a later section of this chapter, a technological innovation embodies information and thus reduces uncertainty about cause-effect relationships in problem solving. For instance, my adoption of residential solar panels for water heating reduces my uncertainty about future price increases in the cost of oil. We find it useful to conceptualize the diffusion and adoption of innovations in terms of a framework based on information and uncertainty. The use of these key concepts helps us to understand the diffusion of technological innovations as one type of communication process.

Diffusion is a kind of *social change,* defined as the process by which alteration occurs in the structure and function of a social system. When new ideas are invented, diffused, and are adopted or rejected, leading to certain consequences, social change occurs. Of course, such change can happen in other ways too, for example, through a political revolution or through a natural event like a drought or earthquake.

Some authors restrict the term "diffusion" to the spontaneous, unplanned spread of new ideas, and use the concept of "dissemination" for diffusion that is directed and managed. We use diffusion and dissemination interchangeably in this book because the distinction often is not very clear in actual practice. And the general convention is to use the word "diffusion" to include both the planned and the spontaneous spread of new ideas.

*"Information is something which reduces uncertainty. Communication is exchange of information. Most writers in the field of communication research would have no difficulty in agreeing with the first definition above. Just as many writers, no doubt, would like to change the second definition" (Wiio, 1980, p. 18).

But we do find it useful to distinguish between centralized and decentralized diffusion systems. In a centralized diffusion system, decisions about such matters as when to begin diffusing an innovation, who should evaluate it, and through what channels it will be diffused, are made by a small number of officials and/or technical experts at the head of a change agency. In a decentralized diffusion system, such decisions are more widely shared by the clients and potential adopters; here, horizontal networks among the clients are the main mechanism through which innovations spread. In fact, in extremely decentralized diffusion systems there may not be a change agency; potential adopters are solely responsible for the self-manage ment of the diffusion of innovations. New ideas may grow out of the practical experience of certain individuals in the client system, rather than coming from formal R & D activities. Originally, it was assumed that relatively centralized diffusion systems like the agricultural extension service were an essential ingredient in the diffusion process, but in recent years several relatively decentralized diffusion systems have been investigated and evaluated, and found to represent an appropriate alternative to centralized diffusion under certain conditions (as detailed in Chapter 9).

Controlling Scurvy in the British Navy: **Innovations Do Not Sell Themselves**

Many technologists think that advantageous innovations will sell themselves, that the obvious benefits of a new idea will be widely realized by potential adopters, and that the innovation will therefore diffuse rapidly. Unfortunately, this is very seldom the case. Most innovations, in fact, diffuse at a surprisingly slow rate.

Scurvy control provides an interesting historical case of how slowly an obviously beneficial innovation spread (Mosteller, 1981). In the early days of long sea voyages, scurvy was the worst killer of the world's sailors, worse than warfare, accidents, and all other causes of death. For instance, of Vasco de Gama's crew of 160 men who sailed with him around the Cape of Good Hope in 1497, 100 died of scurvy. In 1601, an English sea captain, James Lancaster, conducted a kind of experiment to evaluate the ability of

lemon juice to prevent scurvy. Captain Lancaster commanded four ships that sailed from England on a voyage to India; he served three teaspoonfuls of lemon juice every day to the sailors on the biggest of his four ships. Most of these men stayed healthy. But on the three smaller ships, by the halfway point in the journey, 110 out of 278 sailors had died from scurvy. The three smaller ships constituted Lancaster's "control group"; they were not given any lemon juice. So many of these sailors were sick, in fact, that Lancaster had to transfer men from the large ship to staff the three smaller ships.

These results were so clear-cut that one might expect that the British Navy would decide to adopt citrus juice as a scurvy prevention on all its ships, or at least to carry out further investigations on the effects of citrus fruit. But it was not until 1747, *about 150 years later,* that James Lind, a British Navy physician who knew of Lancaster's results, carried out another experiment on the ship *Salisbury.* To each scurvy patient on this ship, Lind prescribed either two oranges and one lemon, or one of five other diets; a half-pint of sea water, six spoonfuls of vinegar, a quart of cider, nutmeg, or seventy-five drops of vitriol elixir. The scurvy patients who got the citrus fruits were cured in a few days, and were able to help Dr. Lind care for the other patients. Unfortunately, the supply of oranges and lemons was exhausted in six days.

Certainly, with this further solid evidence of the ability of citrus fruits to combat scurvy, one would expect the British Navy to adopt this technological innovation for all ship's crews on long sea voyages, and in fact, it did so. *But not until 1795, forty-eight years later.* Scurvy was immediately wiped out. And after a further wait of only *seventy more years, in 1865,* the British Board of Trade adopted a similar policy, and eradicated scurvy in the merchant marine.

Why were naval authorities so slow to adopt the idea of citrus for scurvy prevention? Historians are not able to provide a very clear explanation. But it seems that other, competing remedies for scurvy were also being proposed, and each such cure had its champions. For example, Captain Cook's reports from his voyages in the Pacific did not provide support for curing scurvy with citrus fruits. Further, Dr. Lind was not a very prominent figure in the field of naval medicine, and so his experimental findings did not get much attention in the British Navy. While scurvy prevention was generally resisted for years by the British Navy, other innovations like new ships and new guns were accepted more readily.

Many other historical illustrations could also be cited to show that more than just a beneficial innovation is necessary for its diffusion and adoption to occur. The reader may think that such slow diffusion could only happen in the distant past, before a scientific and experimental approach to evaluating innovations was very well accepted. We answer by calling the reader's attention to the contemporary case of the nondiffusion of the Dvorak typewriter keyboard.

Nondiffusion of the Dvorak Keyboard*

Most of us who use a typewriter—and this includes about 18 million individuals who earn their living as typists—don't even know that our fingers tap out words on a keyboard that is called "QWERTY," named after the first six keys in the upper row of letters. Even fewer of us know just how inefficient the QWERTY keyboard is. For example, this typewriter keyboard takes twice as long to learn as it should, requires twice as long to use as it should, and makes us work about twenty times harder than we should. But QWERTY has persisted out of inertia since 1873, and today unsuspecting individuals are still being taught to use the QWERTY keyboard, unaware that a much more efficient typewriter keyboard is available.

Where did QWERTY come from, and why does it continue to be used, instead of much more efficient alternative keyboard designs? QWERTY was invented by Christopher Latham Sholes in 1873, who designed this keyboard to slow the typist down. In that day, the type bars on a typewriter hung down in a sort of basket, and pivoted up to strike the paper; then they fell back in place by gravity. When two adjoining keys were struck rapidly in succession, they often jammed. Sholes rearranged the keys on a typewriter keyboard to minimize such jamming; he "anti-engineered" the arrangement to make the most commonly used letter sequences awkward and slow to use. By thus making it difficult for a typist to operate the machine, and slowing down typing speed, Sholes' QWERTY keyboard allowed these old typewriters to operate satisfactorily. His design was used in the manufacture of all typewriters.

Prior to about 1900, most typists used the two-finger, hunt-and-peck system. But thereafter, as touch typing became popular, dissatisfaction with the QWERTY keyboard began to grow. Typewriters became mechanically more efficient, and the QWERTY keyboard design was no longer necessary to prevent key jamming. The search for an improved design was led by Professor August Dvorak at the University of Washington, who in 1932 used time-and-motion studies to create a much more efficient keyboard arrangement. The Dvorak keyboard has the letters A, O, E, U, I, D, H, T, N, and S across the home row of the typewriter. Less frequently used letters were placed on the upper and lower rows of keys. About 70 percent of the typing is done on the home row, 22 percent on the upper row, and 8 percent on the lower row. On the Dvorak keyboard, the amount of work assigned to each finger is proportionate to its skill and strength. Further, Professor Dvorak engineered his keyboard so that successive keystrokes fell on alternative hands; thus, while a finger on one hand is stroking a key, a finger on the other hand can be moving into position to hit the next key. Typing rhythm is thus facilitated; this hand alternation was achieved by putting the vowels

* Further detail on the Dvorak keyboard may be found in Dvorak et al (1936), Parkinson (1972), and Lessley (1980).

(which represent 40 percent of all letters typed) on the left-hand side, and placing the major consonants that usually accompany these vowels on the right-hand side of the keyboard.

Professor Dvorak was able to avoid many of the typing inefficiencies of the QWERTY keyboard. For instance, QWERTY overloads the left hand; it must type 57 percent of ordinary copy. The Dvorak keyboard shifts this emphasis to 56 percent on the stronger right hand and 44 percent on the weaker left hand. Only 32 percent of typing is done on the home row with the QWERTY system, compared to 70 percent with the Dvorak keyboard. And the newer arrangement requires less jumping back and forth from row to row; with the QWERTY keyboard, a good typist's fingertips travel more than twelve miles a day, jumping from row to row. These unnecessary intricate movements cause mental tension, typist fatique, and lead to more typographical errors.

One might expect, on the basis of its overwhelming advantages, that the Dvorak keyboard would have completely replaced the inferior QWERTY keyboard by now. On the contrary, after more than 40 years, almost all typists are still using the inefficient QWERTY keyboard. Even though the American National Standards Institute and the Computer and Business Equipment Manufacturers Association have approved the Dvorak keyboard as an alternate design, it is still almost impossible to find a typewriter (or a computer) keyboard that is arranged in the more efficient layout. Vested interests are involved in hewing to the old design: manufacturers, sales outlets, typing teachers, and typists themselves.

No, technological innovations are not always diffused and adopted rapidly. Even when the innovation has obvious and proven advantages.

As the reader may have guessed by now, the present pages were typed on a QWERTY keyboard.

Four Main Elements in the Diffusion of Innovations

Previously we defined *diffusion* as the process by which (1) an *innovation* (2) is *communicated* through certain *channels* (3) *over time* (4) among the members of a *social system.* The four main elements are the innovation, communication channels, time, and the social system (Figure 1-1). They are identifiable in every diffusion research study, and in every diffusion campaign or program (like the diffusion of water boiling in a Peruvian village).

The following description of these four elements in diffusion constitutes an overview of the main concepts and viewpoints that will be detailed in Chapters 2 through 11.

1. The Innovation

An *innovation* is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. It matters little, so far as human behavior is concerned, whether or not an idea is "objectively" new as measured by the lapse of time since its first use or discovery. The perceived newness of the idea for the individual determines his or her reaction to it. If the idea seems new to the individual, it is an innovation.

Newness in an innovation need not just involve new knowledge. Someone may have known about an innovation for some time but not yet developed a favorable or unfavorable attitude toward it, nor have adopted or rejected it. The "newness" aspect of an innovation may be expressed in terms of knowledge, persuasion, or a decision to adopt.

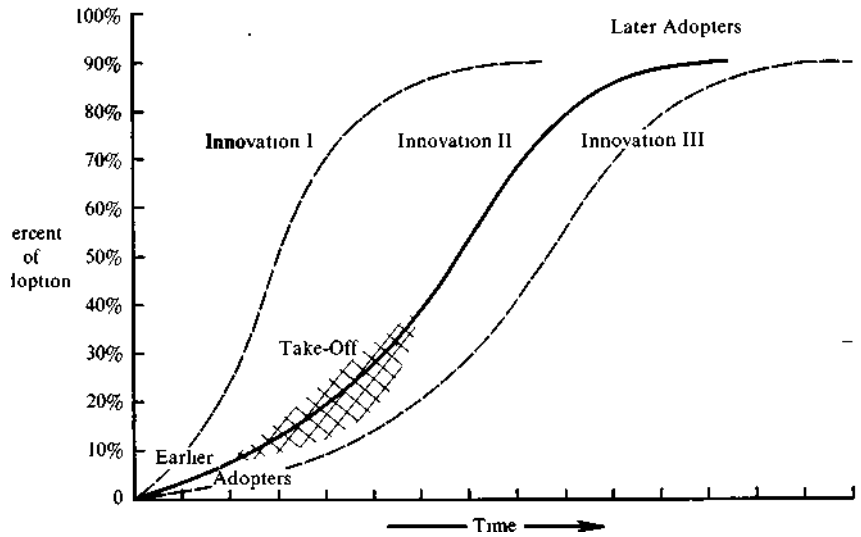

Figure 1-1. Diffusion is the process by which (1) an *innovation* (2) is *communicated* through certain *channels* (3) over *time* (4) among the members of a *social system.*

Among the important research questions addressed by diffusion scholars are (1) how the earlier adopters differ from the later adopters of an innovation (Chapter 7), (2) how the perceived attributes of an innovation, such as its relative advantage, compatibility, etc., affect its rate of adoption, whether relatively more rapidly (as for innovation I above) or more slowly (innovation III), as is detailed in Chapter 6, and (3) why the s-shaped diffusion curve "takes off" at about 10 to 25 percent adoption, when interpersonal networks become activated (Chapter 8).

It should not be assumed that the diffusion and adoption of all innovations are necessarily desirable. In fact, there are some studies of harmful and uneconomical innovations that are generally not desirable for either the individual or his or her social system. Further, the same innovation may be desirable for one adopter in one situation but undesirable for another potential adopter in a different situation. For example, mechanical tomato pickers have been adopted rapidly by large commercial farmers in California, but these machines were too expensive for small-sized tomato growers, and thousands have thus been forced out of tomato production (Chapter 4).

TECHNOLOGICAL INNOVATIONS, INFORMATION, AND UNCERTAINTY

Almost all of the new ideas analyzed in this book are technological innovations, and we often use "innovation" and "technology" as synonyms. A *technology* is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome.* A technology usually has two components: (1) a *hardware* aspect, consisting of the tool that embodies the technology as material or physical objects, and (2) a *software* aspect, consisting of the information base for the tool. For example, we often speak of (1) "computer hardware," consisting of semiconductors, transistors, electrical connections, and the metal frame to protect these electronic components, and (2) "computer software," consisting of the coded commands, instructions, and other information aspects of this tool that allow us to use it to extend human capabilities in solving certain problems. Here we see an illustration of the close interaction between a tool and the way it is used. The social embedding of the hardware aspects of technology are usually less visible than its machinery or equipment, and so we often think of technology mainly in hardware terms. Indeed, sometimes the hardware side of a technology is dominant. But in other cases, a technology may be almost entirely comprised of information; examples are a conservative political philosophy, a religious idea like Transcendental Meditation, a news event, a rumor, assembly-line production, and management by objective (MBO). The diffusion of such software innovations has been investigated, although a methodological problem in such studies is that their adoption cannot be so easily traced or observed in a physical sense.

*This definition is based upon Thompson (1967) and on personal communication with Dr. J. D. Eveland of the National Science Foundation. Both stress the uncertainty-reduction aspect of technology, and thus the important role of information, a view of technology that has not been very widely recognized.

But even though the software component of a technology is often not so apparent to observation, we should not forget that technology almost always represents a mixture of hardware and software aspects. According to our definition of technology, it is a means of uncertainty reduction for individuals that is made possible by the information about cause-effect relationships on which the technology is based. This information usually comes from scientific R & D activities when the technology is being developed, but sometimes a new technology comes out of practice (even then, it is often subjected to a scientific evaluation before it is widely diffused). Thus, there is generally an implication that a technological innovation has at least some degree of benefit or advantage for its potential adopters. But this advantage is not always very clear-cut or spectacular, at least not in the eyes of the intended adopters. They can seldom be very certain that an innovation represents a superior alternative to the previous practice that it might replace.

So a technological innovation creates one kind of uncertainty in the minds of potential adopters (about its expected consequences), as well as representing an opportunity for reduced uncertainty in another sense (that of the information base of the technology). The latter type of potential uncertainty reduction (the information embodied in the technological innovation itself) represents the possible efficacy of the innovation in solving an individual's felt need or perceived problem; this advantage provides the motivation that impels an individual to exert effort in order to learn about the innovation. Once such information-seeking activities have reduced the uncertainty about the innovation's expected consequences to a tolerable level for the individual, a decision concerning adoption or rejection will be made. If the new idea is used by the individual, further evaluative information about the technological innovation is thus obtained and uncertainty about its effects is further reduced. Thus, the innovation-decision process is essentially an information-seeking and information-processing activity in which the individual is motivated to reduce uncertainty about the advantages and disadvantages of the innovation (Chapter 5).

For the sake of clarity, we need to distinguish between the two kinds of information that we have been discussing in respect to a technological innovation.

1. *Software information,* which is embodied in a technology and serves to reduce uncertainty about the cause-effect relationships involved in achieving a desired outcome.
2. *Innovation-evaluation information,* which is the reduction in uncertainty about an innovation's expected consequences.

The main questions that an individual typically asks in regard to software information are, "What is the innovation?" "How does it work?" and "Why does it work?" In contrast, the individual usually wants to know such innovation-evaluation information as, "What are the innovation's consequences?" and "What will its advantages and disadvantages be in my situation?"

TECHNOLOGY CLUSTERS

One of the conceptual and methodological issues facing diffusion researchers and practitioners is the determination of the boundaries around a technological innovation. In essence, the practical problem is how to determine where one innovation stops and another one begins. If an innovation is an idea that is perceived as new, the boundary question obviously ought to be answered by the potential adopters who do the perceiving. In fact, this approach is used by diffusion scholars and by market researchers in "positioning" studies (described in Chapter 6). For example, a California study of the diffusion of recycling found that households that recycled paper were also likely to recycle bottles and cans, but that many families only recycled paper (Leonard-Barton and Rogers, 1980a); presumably the two recycling behaviors represented two innovations that were part of an interrelated cluster. A *technology cluster* consists of one or more distinguishable elements of technology that are perceived as being closely interrelated. Some change agencies promote a cluster or package of innovations because they find that the innovations are thus adopted more rapidly.

CHARACTERISTICS OF INNOVATIONS

It should not be assumed, as sometimes has been done in the past, that all innovations are equivalent units of analysis. This is a gross oversimplification. While it may take consumer innovations like blue jeans or pocket calculators only five or six years to reach widespread adoption in the United States, other new ideas such as the metric system or using seat belts in cars may require several decades to reach complete use. The characteristics of innovations, as perceived by individuals, help to explain their different rate of adoption.

1. *Relative advantage* is the degree to which an innovation is perceived as better than the idea it supersedes. The degree of relative advantage may be measured in economic terms, but social-prestige factors, convenience, and satisfaction are also often important components. It does not matter so much whether an innovation has a great deal of "objective" advantage. What does matter is whether an individual perceives the innovation as advantageous. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption is going to be.

2. *Compatibility* is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. An idea that is not compatible with the prevalent values and norms of a social system will not be adopted as rapidly as an innovation that is compatible. The adoption of an incompatible innovation often requires the prior adoption of a new value system. An example of an incompatible innovation is the use of contraception in countries where religious beliefs discourage use of birth-control techniques, as in Moslem and Catholic nations.

3. *Complexity* is the degree to which an innovation is perceived as difficult to understand and use. Some innovations are readily understood by most members of a social system; others are more complicated and will be adopted more slowly. For example, the villagers in Los Molinos did not understand germ theory, which the health worker tried to explain to them as a reason for boiling their drinking water. In general, new ideas that are simpler to understand will be adopted more rapidly than innovations that require the adopter to develop new skills and understandings.

4. *Trialability* is the degree to which an innovation may be experimented with on a limited basis. New ideas that can be tried on the installment plan will generally be adopted more quickly than innovations that are not divisible. Ryan and Gross (1943) found that every one of their Iowa farmer respondents adopted hybrid-seed corn by first trying it on a partial basis. If the new seed could not have been sampled experimentally, its rate of adoption would have been much slower. An innovation that is trialable represents less uncertainty to

the individual who is considering it for adoption, as it is possible to learn by doing.

3. *Observability* is the degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt. Such visibility stimulates peer discussion of a new idea, as friends and neighbors of an adopter ask him or her for innovation-evaluation information about it. Solar panels on a household's roof are highly observable, and a California survey found that the typical solar adopter showed his equipment to about six of his peers (Rogers et al, 1979).

About one-fourth of all California homeowners know someone who has adopted solar equipment (even though only about 2.5 percent of the state's homeowners had adopted by 1979), and about two-thirds of this one-fourth (15 percent of all homeowners) have seen their friend's solar panels. Solar adopters often are found in spatial clusters in California, with three or four adopters located on the same block. Other consumer innovations like home computers or videotape recorders are relatively less observable, and thus may diffuse more slowly.

In general, innovations that are perceived by receivers as having greater relative advantage, compatibility, trialability, observability, and less complexity will be adopted more rapidly than other innovations. These are not the only qualities that affect adoption rates, but past research indicates that they are the most important characteristics of innovations in explaining rate of adoption.

RE-INVENTION

Until about the mid-1970s, it was assumed that an innovation was an invariant quality that was not changed as it diffused. I remember interviewing an Iowa farmer in 1954 about his adoption of 2,4-D weed spray. In answer to my question about whether he used this innovation, the farmer described in some detail the particular and unusual ways in which he used the weed spray on his farm. At the end of his remarks, I simply checked "adopter" on my questionnaire. The concept of re-invention was not in my theoretical repertoire, so I condensed his experience into one of my existing categories.

Then, in the 1970s, diffusion scholars began to pay more attention to the concept of *re-invention*, defined as the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation. Some researchers measured re-invention as the degree to which an individual's use of a new idea departed from the "mainline" version of the innovation that was promoted by a change agency (Eveland et al, 1977). Once scholars became aware of the concept of re-invention and began to work out measures for it, they began to find that a fair degree of re-invention occurred for some innovations. Other innovations are more difficult or impossible to re-invent; for example, hybrid seed corn does not allow a farmer much freedom to re-invent, as the hybrid vigor is genetically locked into seed (for the first generation) in ways that are too complicated for a farmer to change. But certain other innovations are more flexible in nature, and they are re-invented by many adopters who implement them in different ways.

We should remember, therefore, that an innovation is not necessarily invariant during the process of its diffusion. And adopting an innovation is not necessarily a passive role of just implementing a standard template of the new idea.

Given that an innovation exists, communication must take place if the innovation is to spread beyond its inventor. Now we turn our attention to this second element in diffusion.

2. Communication Channels

Previously we defined *communication* as the process by which participants create and share information with one another in order to reach a mutual understanding. Diffusion is a particular type of communication in which the information that is exchanged is concerned with new ideas. The essence of the diffusion process is the information exchange by which one individual communicates a new idea to one or several others. At its most elementary form, the process involves: (1) an innovation, (2) an individual or other unit of adoption that has knowledge of, or experience with using, the innovation, (3) another individual or other unit that does not yet have knowledge of the innovation, and (4) a communication channel connecting the two units. A *communication channel* is the means by which messages get from one individual to another. The nature of the information-exchange relationship between the pair of individuals determines the conditions under which a source will or will not transmit the innovation to the receiver, and the effect of the transfer.

For example, mass media channels are often the most rapid and ef-

ficient means to inform an audience of potential adopters about the existence of an innovation, that is, to create awareness-knowledge. *Mass media channels* are all those means of transmitting messages that involve a mass medium, such as radio, television, newspapers, and so on, which enable a source of one or a few individuals to reach an audience of many. On the other hand, interpersonal channels are more effective in persuading an individual to adopt a new idea, especially if the interpersonal channel links two or more individuals who are near-peers. *Interpersonal channels* involve a face-to-face exchange between two or more individuals.

The results of various diffusion investigations show that most individuals do not evaluate an innovation on the basis of scientific studies of its consequences, although such objective evaluations are not entirely irrelevant, especially to the very first individuals who adopt. Instead, most people depend mainly upon a subjective evaluation of an innovation that is conveyed to them from other individuals like themselves who have previously adopted the innovation. This dependence on the communicated experience of near-peers suggests that the heart of the diffusion process is the modeling and imitation by potential adopters of their network partners who have adopted previously (Chapter 8).

HETEROPHILY AND DIFFUSION

An obvious principle of human communication is that the transfer of ideas occurs most frequently between two individuals who are alike, similar, or homophilous. *Homophily* * is the degree to which pairs of individuals who interact are similar in certain attributes, such as beliefs, education, social status, and the like. In a free-choice situation, when an individual can interact with any one of a number of other individuals, there is a strong tendency for him to select someone who is most like him- or herself.

There are many reasons for this principle of homophily. Similar

*This concept and its opposite, heterophily, were first called to scientific attention by Lazarsfeld and Merton (1964, p. 23). *Heterophily,* the mirror opposite of homophily, is defined as the degree to which pairs of individuals who interact are different in certain attributes. The term homophily derives from the Greek word *homoios,* meaning alike or equal. Thus, homophily literally means affiliation or communication with a similar person.

individuals usually belong to the same groups, live or work near each other, and are drawn by the same interests. This physical and social propinquity makes homophilous communication more likely. Such communication is also more likely to be effective, and thus to be rewarding. *More effective communication occurs when two individuals are homophilous.* * When they share common meanings, a mutual subcultural language, and are alike in personal and social characteristics, the communication of ideas is likely to have greater effects in terms of knowledge gain, attitude formation and change, and overt behavior change. When homophily is present, communication is therefore likely to be more rewarding to both individuals. As they become gradually conditioned to homophily, the choice of other homophilous network partners is made even more likely.

One of the most distinctive problems in the communication of innovations is that the participants are usually quite heterophilous. A change agent, for instance, is more technically competent than his clients. This difference frequently leads to ineffective communication. They simply do not talk the same language. In fact, when two individuals are identical regarding their technical grasp of an innovation, no diffusion can occur as there is no new information to exchange. The very nature of diffusion demands that at least some degree of heterophily be present between the two participants.* Ideally, they would be homophilous on all other variables (education, social status, and the like) even though they are heterophilous regarding the innovation. Usually, however, the two individuals are heterophilous on all of these variables because knowledge and experience with an innovation are highly related to social status, education, and the like.

* A further refinement of this proposition includes the concept *of empathy,* defined as the ability of an individual to project him- or herself into the role of another: *more effective communication occurs when two individuals are homophilous, unless they have high empathy.* Heterophilous individuals who have high empathy are, in a social-psychological sense, really homophilous. The proposition about effective communication and homophily can also be reversed: *effective communication between two individuals leads to greater homophily in knowledge, beliefs, and overt behavior.*

*We shall see in later chapters that individuals often seek network links with others who are slightly, but not too much, more technically competent about innovations than themselves. For instance, opinion leaders who are sought for information about innovations are usually somewhat more innovative in adopting new ideas than their followers, yet the opinion leaders are seldom innovators, seldom the very first to adopt. This suggests that there is an optimal degree of heterophily in interpersonal networks for effective diffusion to occur.

3. Time

Time is an important element in the diffusion process. In fact, most other behavioral science research is timeless in the sense that the time dimension is simply ignored. Time is an obvious aspect of any communication process, but most (nondiffusion) communication research does not deal with it explicitly. Perhaps it is a fundamental concept that cannot be explained in terms of something more fundamental (Whitrow, 1980, p. 372). Time does not exist independently of events, but it is an aspect of every activity.

The inclusion of time as a variable in diffusion research is one of its strengths, but the measurement of the time dimension (often by means of respondents' recall) can be criticized (as we point out in Chapter 3). The time dimension is involved in diffusion (1) in the innovation-decision process by which an individual passes from first knowledge of an innovation through its adoption or rejection, (2) in the innovativeness of an individual or other unit of adoption—that is, the relative earliness/lateness with which an innovation is adopted—compared with other members of a system, and (3) in an innovation's rate of adoption in a system, usually measured as the number of members of the system that adopt the innovation in a given time period.

THE INNOVATION-DECISION PROCESS

The *innovation-decision process* is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision. We conceptualize five main steps in the process: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. *Knowledge* occurs when an individual (or other decision-making unit) is exposed to the innovation's existence and gains some understanding of how it functions. *Persuasion* occurs when an individual (or other decision-making unit) forms a favorable or unfavorable attitude toward the innovation. *Decision* occurs when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation. *Implementation* occurs when an individual (or other decision-making unit) puts an innovation into use. Re-invention is especially likely to occur at the implementation stage. *Confirmation* occurs when an individual (or other decision-making unit) seeks reinforcement of an innovation decision that has already been made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation.

Previously we stated that the innovation-decision process is an information-seeking and information-processing activity in which an individual obtains information in order to decrease uncertainty about the innovation. At the knowledge stage an individual mainly seeks software information that is embodied in a technological innovation, information that reduces uncertainty about the cause-effect relationships that are involved in the innovation's capacity to solve a problem. At this stage an individual wants to know what the innovation is, and how and why it works. Mass-media channels can effectively transmit such software information.

But increasingly at the persuasion stage, and especially at the deci sion stage, an individual seeks innovation-evaluation information in order to reduce uncertainty about an innovation's expected consequences. Here an individual wants to know the innovation's advantages and disadvantages in his or her own situation. Interpersonal networks with near-peers are particularly able to carry such evaluative information about an innovation. Such subjective evaluations of a new idea are especially likely to influence an individual at the decision stage, and perhaps at the confirmation stage.

The innovation-decision process can lead to either *adoption,* a decision to make full use of an innovation as the best course of action available, or to *rejection,* a decision not to adopt an innovation. Such decisions can be reversed at a later point; for example, *discontinuance* is a decision to reject an innovation after it had previously been adopted. Discontinuance may occur because an individual becomes dissatisfied with an innovation, or because the innovation is replaced with an improved idea. It is also possible for an individual to adopt the innovation after a previous decision to reject it. Such later adoption and discontinuance occur during the confirmation stage of the innovation-decision process.

The innovation-decision process involves time in the sense that the five steps usually occur in a time-ordered sequence of knowledge, persuasion, decision, implementation, and confirmation. The *innovation-decision period* is the length of time required to pass through the innovation-decision process. Exceptions to the usual sequence of the five stages may occur, such as when the decision stage precedes the persuasion phase.

For purposes of simplicity, we have restricted our present discus-

sion of the innovation-decision process mainly to a single individual, and thus to the case of individual-optional innovation-decisions. But many innovation-decisions are made by organizations or other types of adopting units, rather than by individuals. For example, an organization may decide to purchase word-processing equipment on the basis of a staff decision or by an official's authority decision; the individual office worker in the organization may have little or no say in the innovation-decision. When an innovation-decision is made by a system, rather than by an individual, the decision process is usually much more complicated (we discuss the innovation-decision process in organizations in Chapter 10).

Nevertheless, time is still an important dimension in this innovation-decision process.

INNOVATIVENESS AND ADOPTER CATEGORIES

Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system. Rather than describing an individual as "less innovative than the average member of a social system," it is handier and more efficient to refer to the individual as being in the "late majority" or some other adopter category. This short-hand notation saves words and contributes to clearer understanding, for diffusion research shows that members of each of the adopter categories have a great deal in common. If the individual is like most others in the late majority category, he is low in social status, makes little use of mass-media channels, and secures most of his new ideas from peers via interpersonal channels. In a similar manner, we shall present a concise word-picture of each of the other four adopter categories (in Chapter 7). *Adopter categories* are the classifications of members of a social system on the basis of innovativeness. The five adopter categories are: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards.

Innovators are active information seekers about new ideas. They have a high degree of mass media exposure and their interpersonal networks extend over a wide area, usually reaching outside of their local system. Innovators are able to cope with higher levels of uncertainty about an innovation than are other adopter categories. As the first to adopt a new idea in their system, they cannot depend upon the

subjective evaluations of the innovation from other members of their system.

Obviously, the measure of innovativeness and the classification of the system's members into adopter categories are based upon the relative time at which an innovation is adopted.

RATE OF ADOPTION

There is a third specific way in which the time dimension is involved in the diffusion of innovations. *Rate of adoption* is the relative speed with which an innovation is adopted by members of a social system. When the number of individuals adopting a new idea is plotted on a cumulative frequency basis over time, the resulting distribution is an s-shaped curve. At first, only a few individuals adopt the innovation in each time period (such as a year or a month, for example); these are the innovators. But soon the diffusion curve begins to climb, as more and more individuals adopt. Then the trajectory of the rate of adoption begins to level off, as fewer and fewer individuals remain who have not yet adopted. Finally, the s-shaped curve reaches its asymptote, and the diffusion process is finished.

Most innovations have an s-shaped rate of adoption. But there is variation in the slope of the "s" from innovation to innovation; some new ideas diffuse relatively rapidly and the s-curve is quite steep. Another innovation may have a slower rate of adoption, and its s-curve will be more gradual, with a slope that is relatively lazy. One issue addressed by diffusion research is why some innovations have a rapid rate of adoption, and why others are adopted more slowly (Figure 1-1).

The rate of adoption is usually measured by the length of time required for a certain percentage of the members of a system to adopt an innovation. Therefore, we see that rate of adoption is measured using an innovation or a system, rather than an individual, as the unit of analysis. Innovations that are perceived by individuals as possessing greater relative advantage, compatibility, and the like, have a more rapid rate of adoption (as we pointed out previously in this chapter).

There are also differences in the rate of adoption for the same innovation in different social systems. Clearly, there are aspects of diffusion that cannot be explained only by the nature of individual behavior. The system has a direct effect on diffusion, and also an *in-*

direct influence through its individual members. What is a social system?

4. A Social System

A *social system* is defined as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. The members or units of a social system may be individuals, informal groups, organizations, and/or subsystems. The system analyzed in a diffusion study may consist of all the peasants in an Asian village, high schools in Wisconsin, medical doctors in a hospital, or all the consumers in the United States. Each unit in a social system can be distinguished from other units. All members cooperate at least to the extent of seeking to solve a common problem in order to reach a mutual goal. This sharing of a common objective binds the system together.

It is important to remember that diffusion occurs within a social system, because the social structure of the system affects the innovation's diffusion in several ways. The social system constitutes a boundary within which an innovation diffuses. Here we shall deal with the following topics: how the social structure affects diffusion, the effect of norms on diffusion, the roles of opinion leaders and change agents, types of innovation decisions, and the consequences of innovation. All these issues involve relationships between the social system and the diffusion process that occurs within it.

SOCIAL STRUCTURE AND DIFFUSION

To the extent that the units in a social system are not all identical in their behavior, structure then exists within the system. We define *structure* as the patterned arrangements of the units in a system. This structure gives regularity and stability to human behavior in a social system; it allows one to predict behavior with some degree of accuracy. Thus, structure represents one type of information in that it decreases uncertainty. Perhaps we see an illustration of this predictability that is provided by structure in a bureaucratic organization like a government agency; there is a well-developed social structure in such a system consisting of hierarchical positions, giving officials in higher-ranked positions the right to issue orders to individuals of lower rank. Their orders are expected to be carried out. Such patterned social relationships among the members of a system constitute *social* structure, one type of structure.

In addition to this formal structure among the units in a social system, there is also an informal type of structure that exists in the interpersonal networks linking a system's members, determining who interacts with whom and under what circumstances. We define such *communication structure* as the differentiated elements that can be recognized in the patterned communication flows in a system. Previously we mentioned the homophily principle, that most individuals in a system talk with others who are similar to themselves; a communication structure is thus often created in a system in which homophilous sets of individuals are grouped together in cliques. A complete lack of communication structure in a system would be represented by a situation in which each individual talked with equal probability to each other member of the system. Such a situation might occur when a set of complete strangers first come together. But regularized patterns soon begin to occur in the communication network of the system. And these aspects of communication structure predict, in part, the behavior of individual members of the social system.

The structure of a social system can facilitate or impede the diffusion of innovations in the system. The impact of the social structure on diffusion is of special interest to sociologists and social psychologists, and the way in which the communication structure of a system affects diffusion is a particularly interesting topic for communication scholars. Katz (1961) remarked, "It is as unthinkable to study diffusion without some knowledge of the social structures in which potential adopters are located as it is to study blood circulation without adequate knowledge of the structure of veins and arteries."

Compared to other aspects of diffusion research, however, there have been relatively few studies of how the social or communication structure of a system affects the diffusion and adoption of innovations in that system. One explanation may be that, methodologically, it is a rather tricky business to untangle the effects of a system's structure on diffusion, independent from the effects of the characteristics of the individuals that make up the system. But let us consider an illustration of *system effects,* the influences of the structure and/or composition of a system on the behavior of the members of the system. Our example is drawn from a study by Rogers and Kincaid (1981, pp. 239-240): two Korean women are both illiterate, married, have two children, and are twenty-nine years of age. The husbands of both women are high-school graduates, with farms of five acres. One might

expect that both women would be about equally likely, or unlikely, to adopt a contraceptive method.

But the two women are different in one crucial respect: they live in different villages, one in Village A and one in Village B. The rate of adoption of family-planning methods is 57 percent in Village A, and only 26 percent in Village B. Obviously, the social and communication structures of these two villages are quite different regarding the diffusion of contraception, even though these innovations had been promoted equally in both villages by the national family-planning program in Korea. Certainly, we would predict that the woman in Village A would be more likely to adopt a contraceptive method (than her counterpart in Village B) because of system effects: Mrs. A's friends and neighbors are more likely, since they themselves have adopted, to encourage her to adopt, and the village leaders in Village A are especially committed to family planning, while in Village B they are not.

From this example we can see how a system can have an effect on the diffusion and adoption of innovations, over and above the effect of such variables as the individual characteristics of the members of the system. Individual innovativeness is affected both by the individual's characteristics, and by the nature of the social system in which the individual is a member.

SYSTEM NORMS AND DIFFUSION

The Korean investigation by Rogers and Kincaid (1981, p. 249) also illustrates the importance of village norms in affecting the rate of diffusion of family-planning methods. For example, our study of twenty-four villages found big differences from village to village, both in the level of adoption of family planning and in the adoption of particular types of contraceptive methods. One village had 51 percent adoption of the IUD (intrauterine device) and only one vasectomy adopter. Another village had 23 percent adoption of vasectomy. Yet another was a "pill village" in which all of the adopters chose to use contraceptive pills. Clearly these differences were not due to the nature of the national family-planning program in Korea, which had promoted the same ''cafeteria'' of contraceptive methods in all villages for ten years prior to our data gathering. The explanation for the different contraceptive behavior from village to village had to come mainly from within each village. One explanation was these systems' norms.

Norms are the established behavior patterns for the members of a social system. They define a range of tolerable behavior and serve as a guide or a standard for the members of a social system.

A system's norms can be a barrier to change, as was shown in our example of water boiling in a Peruvian community. Such resistance to new ideas is often found in norms that relate to food habits. In India, for example, sacred cows roam the countryside while millions of people are undernourished. Pork is not consumed by Moslems and Jews. Polished rice is eaten in most of Asia and the United States, even though whole rice is more nutritious. These are examples of cultural and religious norms. Norms can operate at the level of a nation, a religious community, an organization, or a local system like a village.

OPINION LEADERS AND CHANGE AGENTS

We have been discussing the influence of the structure of a system on its members' diffusion and adoption behavior. Now we turn to the different roles that certain individuals play in a social system and the effect of these roles on diffusion. Specifically, we look at two roles: opinion leaders and change agents.

The most innovative member of a system is very often perceived as a deviant from the social system, and he or she is accorded a somewhat dubious status of low credibility by the average members of the system. This individual's role in diffusion (especially in persuading others about the innovation) is therefore likely to be limited. On the other hand, there are members of the system who function in the role of opinion leader. They provide information and advice about innovations to many in the system.

Opinion leadership is the degree to which an individual is able to influence other individuals' attitudes or overt behavior informally in a desired way with relative frequency. It is a type of informal leadership, rather than a function of the individual's formal position or status in the system. Opinion leadership is earned and maintained by the individual's technical competence, social accessibility, and conformity to the system's norms. Much research indicates that when the social system is oriented to change, the opinion leaders are quite innovative; but when the norms are opposed to change, the behavior of the leaders also reflects this norm. By their close conformity to the system's norms, opinion leaders serve as an apt model for the innovation be-

havior of their followers. Opinion leaders thus exemplify and express the system's structure.

In any system, naturally, there may be both innovative opinion leaders and also leaders who oppose change. These influential persons can lead in the promotion of new ideas, or they can head an active opposition. In general, when opinion leaders are compared with their followers, we find that they (1) are more exposed to all forms of external communication, (2) are more cosmopolite, (3) have somewhat higher social status, and (4) are more innovative (although the exact degree of innovativeness depends, in part, on the system's norms). But one of the most striking characteristics of opinion leaders is their unique and influential position in their system's communication structure: they are at the center of interpersonal communication networks. A *communication network* consists of interconnected individuals who are linked by patterned flows of information. The opinion leader's interpersonal networks allow him or her to serve as a social model whose innovative behavior is imitated by many other members of the system. The influence and respect with which the opinion leader is held can be lost, however, as when an opinion leader deviates too far from the norms of his or her system. There is research evidence that opinion leaders can be "worn out" by change agents who overuse them. Opinion leaders may be perceived by their peers as too much like the change agents and may therefore lose their credibility with their former followers.

Opinion leaders are members of the social system in which they exert their influence. In some instances individuals with influence in the social system are professionals who represent change agencies external to the system. A *change agent* is an individual who influences clients' innovation decisions in a direction deemed desirable by a change agency. He or she usually seeks to obtain the adoption of new ideas, but may also attempt to slow down diffusion and prevent the adoption of what he or she believes are undesirable innovations. Change agents use opinion leaders within a given social system as lieutenants in diffusion campaigns.

Change agents are often professionals with university degrees in technical fields. This professional training, and the social status that goes with it, usually means that change agents are heterophilous from their typical clients, thus posing problems for effective communication about the innovations that they are promoting. However, because of a manpower shortage of professionally qualified change agents and/or because of a lack of adequate financial resources to

employ adequate numbers of them, many change agencies use change-agent aides. An *aide* is a less than fully professional change agent who intensively contacts clients to influence their innovation decisions. Aides are usually more homophilous with their average client, and thus provide one means of bridging the heterophily gap frequently found between professional change agents and their client audience.

TYPES OF INNOVATION-DECISIONS

The social system has yet another important kind of influence on the diffusion of new ideas. Innovations can be adopted or rejected (1) by individual members of a system, or (2) by the entire social system, which can decide to adopt an innovation by a collective or an authority decision.

1. *Optional innovation-decisions* are choices to adopt or reject an innovation that are made by an individual independent of the decisions of other members of the system. Even in this case, the individual's decision may be influenced by the norms of his system and by his interpersonal networks. The decision of an individual housewife in Los Molinos to adopt or reject water boiling was an optional innovation-decision, although this choice was often influenced by community factors, like the hot-cold complex. The distinctive aspect of optional innovation-decisions is that the individual is the unit of decision making, rather than the social system.

As stated previously, the classical diffusion model evolved out of early diffusion research, which comprised almost entirely investigations of optional innovation-decisions: the diffusion of hybrid corn among Iowa farmers, the spread of a new antibiotic drug among medical doctors, and the like. Only in the past decade have we begun to expand the scope of the diffusion paradigm also to include collective and authority innovation-decisions.

2. *Collective innovation-decisions* are choices to adopt or reject an innovation that are made by consensus among the members of a System. All of the units in the system usually must conform to the system's decision once it is made. For example, the voters in some California cities and counties have decided that all new homes to be constructed must be equipped with solar water heating, as must any old home that is resold; the individual homeowner has little practical choice but to adopt solar panels. On the other hand, once a city decides to have cable television, each household has to sign up individ-

ually for this new service. The freedom of choice allowed the individual depends on the nature of the collective innovation-decision.

3. *Authority innovation-decisions* are choices to adopt or reject an innovation that are made by a relatively few individuals in a system who possess power, status, or technical expertise. The individual member of the system has little or no influence in the innovation-decision; he or she simply implements the decision. For instance, the president of a large U.S. electronics corporation some years ago decided that all of his male employees should wear white shirts and dark suits; this authority decision had to be followed by every man who worked for this company.

These three types of innovation-decisions range on a continuum from optional decisions (where the adopting individual has almost complete responsibility for the decision), through collective decisions (where the individual has some influence in the decision), to authority decisions (where the adopting individual has no influence in the innovation decision). Collective and authority decisions are probably much more common than optional decisions in formal organizations, such as factories, schools, or government organizations, in comparison with other fields like agriculture and consumer behavior, where many of the innovation-decisions by farmers and consumers are optional.

Generally, the fastest rate of adoption of innovations results from authority decisions (depending, of course, on how innovative the authorities are). Optional decisions can usually be made more rapidly than collective decisions. Although made more rapidly, authority decisions are often circumvented during their implementation.

The type of innovation-decision for a given idea may change or be changed over time. Automobile seat belts, during the early years of their use, were installed in autos as optional decisions by the car's owner, who had to pay the cost of installation. Then, in 1968, a federal law was passed requiring that seat belts be included in all new cars in the United States. An optional innovation-decision thus became a collective decision. But the decision by the auto driver or passengers to fasten the belts when in the car was still an optional decision—that is, except for 1974 model cars, which a federal law required to be equipped with a seat belt-ignition interlock system that prevented the driver from starting the engine until everyone in the auto's front seat had fastened their seat belt. So for one year, the fastening of seat belts became a collective authority-decision. But the public reaction to this draconian approach was so negative that the U.S. legislature reversed this law, and the fastening of auto seat belts again became an individual-optional decision.

There is yet a fourth type of innovation-decision that is a sequential combination of two or more of the three types we have just discussed. *Contingent innovation-decisions* are choices to adopt or reject that can be made only after a prior innovation-decision. For example, an individual member of a social system may be free to adopt or not to adopt a new idea only after his system's innovation-decision. In the example just discussed, until the 1968 law (a collective innovation-decision by elected legislators representing the public), it was difficult for an auto owner to make an optional decision to install seat belts. In a university setting, a professor may not be able to make an optional decision to use a word processor until a prior authority decision to purchase the word-processing equipment has been made by the professor's department chairperson.

One can also imagine other types of contingent innovation decisions in which the first decision is of an authority sort followed by a collective decision. The distinctive aspect of contingent decision making is that two (or more) tandem decisions are required; either of the innovation decisions may be optional, collective, or authority.

The social system is involved directly in collective, authority, and contingent innovation-decisions, and perhaps indirectly in optional innovation-decisions. There is a final way in which the social system plays a role in the diffusion of innovations: it is involved in the consequences of innovations.

CONSEQUENCES OF INNOVATIONS

A social system is involved in an innovation's consequences because certain of these changes occur at the system level, in addition to those that affect the individual. We discuss consequences briefly here and in an expanded form in Chapter 11.

Consequences are the changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation. There are at least three classifications of consequences:

1. *Desirable* versus *undesirable* consequences, depending on whether the effects of an innovation in a social system are functional or dysfunctional.
2. *Direct* versus *indirect* consequences, depending on whether the

changes to an individual or to a social system occur in immediate response to an innovation or as a second-order result of the direct consequences of an innovation.

3. *Anticipated versus unanticipated consequences,* depending on whether the changes are recognized and intended by the members of a social system or not.

Change agents usually introduce innovations into a client system that they expect will be desirable, direct, and anticipated. But often such innovations result in at least some unanticipated consequences that are indirect and undesirable for the system's members. An illustration is the case of the steel ax introduced by missionaries to an Australian aborigine tribe (Sharp, 1952, pp. 69-72). The change agents intended that the new tool should raise levels of living and material comfort for the tribe. But the new technology also led to a breakdown of the family structure, the rise of prostitution, and "misuse" of the innovation itself. Change agents can often anticipate and predict the innovation's form, the directly observable physical appearance of the innovation, and perhaps its function, the contribution of the idea to the way of life of the system's members. But seldom are change agents able to predict another aspect of an innovation's consequences, its meaning, the subjective perception of the innovation by the clients.

Diffusion of Hybrid Corn in Iowa

We have already mentioned the Ryan and Gross (1943) study of the diffusion of hybrid seen corn as one of the most influential diffusion studies of all time. Although more will be said about this study in Chapter 2, it is an ideal illustration at this point because the hybrid corn investigation includes each of the four main elements of diffusion that we have just discussed.

The innovation of hybrid corn was one of the most important new farm technologies when it was released to Iowa farmers in 1928, and it ushered in a whole set of agricultural innovations in the 1930s through the 1950s that amounted to an "agricultural revolution" in farm productivity. Hybrid seed had been developed by agricultural scientists at Iowa State University and at other state land-grant universities. The diffusion of hybrid seed was heavily promoted by the Iowa agricultural extension service and by salesmen from seed companies. Hybrid corn yielded about 20 percent more per acre than the open-pollinated varieties that it replaced, and it was also more drought resistant and better suited to harvest with mechanical corn pickers. But the seed lost its hybrid vigor after the first generation, so farmers had to purchase hybrid seed each year. Previously farmers had saved their own seed, selected from their best-looking corn plants. The adoption of hybrid corn meant that a farmer had to make important changes in his behavior.

In 1941, Bryce Ryan and Neal Gross (1943), two rural sociologists at Iowa State University, personally interviewed 259 farmers living in two small communities. Each of these respondents was asked to recall when and how he had adopted hybrid corn, and to provide certain information about themselves and their farm operation.

All but 2 of the 259 farmers had adopted hybrid corn between 1928 and 1941, a rather rapid rate of adoption. When plotted cumulatively on a year-by-year basis, the adoption rate formed an s-shaped curve over time. After the first five years, by 1933, only 10 percent of the Iowa farmers had adopted. Then, the adoption curve "took off," shooting up to 40 percent adoption in the next three years (by 1936). Soon the rate of adoption began to level off as fewer and fewer farmers remained to adopt the new idea. The overall shape of the rate of adoption looked like an "S" (Figure 1-1).

Farmers were assigned to adopter categories on the basis of when they adopted the new seed (Gross, 1942). Compared to later adopters, the innovators had larger-sized farms, higher incomes, and more years of formal education. The innovators were more cosmopolite, as measured by the number of trips they had taken to Des Moines (Iowa's largest city, located about seventy-five miles away).

Although hybrid corn was an innovation with a high degree of relative advantage over the open-pollinated seed that it replaced, the typical farmer moved rather slowly from awareness-knowledge of the innovation to adoption. The innovation-decision period from first knowledge to the adoption decision averaged about nine years for all respondents, a finding that led to a clearer realization that the innovation-decision process involved considerable deliberation by most adopters, even in the case of an innovation with spectacular results. The average respondent took three or four years after planting his first hybrid seed, usually on a small trial plot, before deciding to plant 100 percent of his corn acreage in hybrid varieties.

Communication channels played different roles at various stages in the innovation-decision process. The typical farmer first heard of hybrid seed from a salesman, but neighbors were the most frequent channel leading to persuasion. Salesmen were more important channels for earlier adopters, and neighbors were more important for later adopters. The Ryan and Gross (1943) findings suggested the important role of interpersonal networks in the diffusion process in a system. The farmer-to-farmer exchange of personal experiences with use of the hybrid seed seemed to lie at the heart of diffusion. When enough such positive experiences were accumulated by farmers (especially the innovators and early adopters) and exchanged within the community, the rate of adoption really took off. This threshold seemed to occur in about 1935. After about that point, it would have been impossible to halt

the further diffusion of hybrid corn. The farm community as a social system, including the networks linking the individual farmers within it, was a crucial element in the diffusion process.

In order to understand the role of diffusion networks and opinion leadership, Ryan and Gross (1943) should have asked sociometric questions* of their respondents, such as "From which other farmers have you obtained information about hybrid corn?" The sample design, which consisted of a complete enumeration in two communities, would have made the use of sociometric questions easy. But "information was simply collected from all community members as if they were unrelated respondents in a random sample" (Katz et al, 1963).

Even without sociometric data about diffusion networks, Ryan and Gross (1943) sensed that hybrid corn spread in the two Iowa communities as a kind of social snowball. They wrote: "There is no doubt but that the behavior of one individual in an interacting population affects the behavior of his fellows. Thus, the demonstrated success of hybrid seed on a few farms offers a changed situation to those who have not been so experimental. The very fact of acceptance by one or more farmers offers new stimulus to the remaining ones." Thus, the two rural sociologists intuitively sensed what later diffusion scholars were to gather more detailed evidence to prove: that the heart of the diffusion process consists of interpersonal network exchanges and social modeling between those individuals who had already adopted and those who then would be influenced to do so.

In her study of the invisible college of rural sociologists investigating diffusion as of the mid-1960s, Crane (1972, p. 74) identified the researchers who first utilized a new concept and/or methodological tool in studying diffusion. According to her analysis, Ryan and Gross deserve credit for launching fifteen of the eighteen most widely used intellectual innovations in the rural sociology research tradition. This is perhaps another way of saying that Bryce Ryan and Neal Gross really formed the classical diffusion paradigm.

As such, the hybrid corn study has left an indelible stamp on the history of diffusion research.

Summary

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. Diffusion is a special type of communication concerned with

* *Sociometry* is a means of obtaining and analyzing quantitative data about communication patterns among the individuals in a system by asking each respondent to whom he or she is linked.

the spread of messages that are new ideas. *Communication* is a process in which participants create and share information with one another in order to reach a mutual understanding. It is the newness of the idea in the message content that gives diffusion its special character, as some degree of uncertainty is thus involved. *Uncertainty* is the degree to which a number of alternatives are perceived with respect to the occurrence of an event and the relative probabilities of these alternatives. The degree of uncertainty can be reduced by an individual by obtaining information. *Information* is a difference in matter-energy that affects uncertainty in a situation where a choice exists among a set of alternatives.

The main elements in the diffusion of new ideas are: (1) an *innovation,* (2) which is *communicated* through certain *channels,* (3) *over time,* (4) among the members of a *social system.* An *innovation* is an idea, practice, or object perceived as new by an individual or other unit of adoption. Almost all of the new ideas discussed in this book are technological innovations. A *technology* is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome. Most technologies have two components: (1) *hardware,* consisting of the tool that embodies the technology as material or physical objects, and (2) *software,* consisting of the knowledge base for the tool. The software information embodied in a technology serves to reduce one type of uncertainty, that concerned with the cause-effect relationships that are involved in achieving a desired outcome. But a technological innovation also creates another kind of uncertainty because of its newness to the individual, and motivates him or her to seek information by means of which the new idea can be evaluated. We call this *innovation-evaluation information;* it leads to a reduction in uncertainty about an innovation's expected consequences.

The characteristics of an innovation, as perceived by the members of a social system, determine its rate of adoption. Five attributes of innovations are: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability.

Re-invention is the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation.

A *communication channel* is the means by which messages get from one individual to another. Mass-media channels are more effective in creating knowledge of innovations, whereas interpersonal channels are more effective in forming and changing attitudes toward the new idea, and thus in influencing the decision to adopt or reject a

new idea. Most individuals evaluate an innovation, not on the basis of scientific research by experts, but through the subjective evaluations of near-peers who have adopted the innovation. These near-peers thus serve as social models, whose innovation behavior tends to be imitated by others in their system.

Another distinctive aspect of diffusion as a subfield of communication is that some degree of heterophily is present. *Heterophily* is the degree to which pairs of individuals who interact are different in certain attributes, such as beliefs, education, social status, and the like. The opposite of heterophily is *homophily,* the degree to which pairs of individuals who interact are similar in certain attributes. Generally, most human communication takes place between individuals who are homophilous, a situation that leads to more effective communication. Therefore, the heterophily that is often present in the diffusion of innovations leads to special problems in securing effective communication.

Time is involved in diffusion in (1) the innovation-decision process, (2) innovativeness, and (3) an innovation's rate of adoption. The *innovation-decision process* is the mental process through which an individual (or other decision-making unit) passes from first knowledge of an innovation to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision. We conceptualize five steps in this process: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. An individual seeks information at various stages in the innovation-decision process in order to decrease uncertainty about the innovation. At the knowledge stage, an individual obtains software information that is embedded in a technological innovation; he or she wants to know what the innovation is and how it works. But at the persuasion and decision stages, an individual seeks innovation-evaluation information in order to reduce uncertainty about an innovation's expected consequences. The decision stage leads (1) to *adoption,* a decision to make full use of an innovation as the best course of action available, or (2) to *rejection,* a decision not to adopt an innovation.

Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system. We specify five *adopter categories,* classifications of the members of a social system on the basis of innovativeness: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards. *Rate of adoption* is the relative speed with which an innovation is adopted by members of a social system.

A *social system* is a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. A system has *structure,* defined as the patterned arrangements of the units in a system, which gives stability and regularity to individual behavior in a system. The social and communication structure of a system facilitates or impedes the diffusion of innovations in the system.

Norms are the established behavior patterns for the members of a social system. Norms are often exemplified in the behavior of the opinion leaders in a system. *Opinion leadership* is the degree to which an individual is able to influence informally other individuals' attitudes or overt behavior in a desired way with relative frequency. A *change agent* is an individual who attempts to influence clients' innovation-decisions in a direction that is deemed desirable by a change agency. An *aide* is a less than fully professional change agent who intensively contacts clients to influence their innovation-decisions.

We distinguish three main types of innovation-decisions: (1) *optional innovation-decisions,* choices to adopt or reject an innovation that are made by an individual independent of the decisions of other members of the system, (2) *collective innovation-decisions,* choices to adopt or reject an innovation that are made by consensus among the members of a system, and (3) *authority innovation-decisions,* choices to adopt or reject an innovation that are made by relatively few individuals in a system who possess power, status, or technical expertise. A fourth category consists of a sequential combination of two or more of these types of innovation-decisions: *contingent innovation-decisions* are choices to adopt or reject that can be made only after a prior innovation-decision.

A final way in which a social system may function as an element in diffusion concerns *consequences,* the changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation.

CHAPTER 2

A History of Diffusion Research

Ironically, it almost seems as if diffusion research in the various research traditions can be said to have been independently invented! Indeed, diffusion researchers in the several traditions which we have examined scarcely know of each other's existence.

Elihu Katz et al (1963), "Traditions of Research on the Diffusion of Innovations."

Diffusion research is thus emerging as a single, integrated body of concepts and generalizations, even though the investigations are conducted by researchers in several scientific disciplines.

Everett M. Rogers with F. Floyd Shoemaker (1971, p. 47), *Communication of Innovations: A Cross-Cultural Approach.*

RESEARCH ON THE DIFFUSION OF INNOVATIONS started in a series of independent intellectual enclaves during its first several decades. Each of these disciplinary cliques of diffusion researchers studied one kind of innovation; for example, rural sociologists investigated the diffusion of agricultural innovations to farmers while educational researchers studied the spread of new teaching ideas among school personnel. Despite the distinctiveness of these approaches to diffusion research, each "invisible college" uncovered remarkably similar findings; for example, that the diffusion of an innovation followed an s-shaped curve over time and that innovators had higher socioeconomic status than later adopters.

My main motivation for writing my first book on this topic, *Diffusion of Innovations* (Rogers, 1962), was to point out the lack of diffusion of diffusion-research, and to argue for greater awareness among the diffusion research traditions. A *research tradition* is a series of investigations on a similar topic in which successive studies are influenced by preceding inquiries. Essentially, each research tradition is an "invisible college" of researchers (or at least a "department" in such an invisible college), a network of scholars who are spatially dispersed but who are closely interconnected by exchanging research findings and other scientific information.

But in the mid-1960s a gradual breakdown began to occur in the formerly impermeable boundaries between the diffusion research traditions. Evidence"of this trend was provided by Rogers with Shoemaker (1971, pp. 46-47), who computed an index of cross-tradition citations for each diffusion publication available by 1968; this index *was* the number of research traditions (other than the author's) represented in the footnotes and bibliography of each empirical diffusion publication. The average index score (per diffusion publication) hovered at less than 1.0 during the 1940s, 1950s, and early 1960s. But between 1965 and 1968, the average score suddenly doubled. Clearly there was a trend toward breaking down the "paper curtains" among the diffusion research traditions.

This trend toward a more unified and cross-disciplinary viewpoint in diffusion research has continued until today; every diffusion scholar is fully aware of the parallel methodologies and results in the other traditions. All of the diffusion research traditions have now merged, intellectually, toward one invisible college, although diffusion studies are still conducted by scholars in several different disciplines. But this merger of diffusion approaches has not been an unmixed blessing. In fact, diffusion studies have begun to display a kind of bland sameness, as they pursue a small number of research issues with rather stereotyped approaches. It seems that the narrow perspectives of diffusion scholars in an earlier era has been replaced lately by an unnecessary and unhealthy standardization in diffusion research. An observer might wonder whether the old days of separate and varied research approaches might have been a richer intellectual approach than the present era of well-informed sameness.

A major theme of this chapter is the story of the recent merging of the diffusion research traditions, and both the good and the bad consequences of this intellectual convergence. In this chapter, we will address such questions as: where did diffusion research come from? How and why did it grow to its present position of wide recognition by scholars, and its widespread use and application by policy makers?

How has acceptance of the classical diffusion model limited the originality and appropriateness of the work of diffusion researchers?

We think this chapter is important because anyone who wishes to learn about and understand diffusion research ought to know the history of how it attained its present status. I have been involved in diffusion research since 1954, and so much of the twenty-eight-year history described here is one that I know personally. I consider myself a loyal and sympathetic, but critical, participant in the history of diffusion research. That viewpoint should be kept in mind when reading the pages that follow.

The Beginnings of Diffusion Research in Europe

Problems with the diffusion of innovations have been recognized for a long time, and thus it should not be surprising that the roots of diffusion research extend back to the European beginnings of social science.

Gabriel Tarde and The Laws of Imitation

Gabriel Tarde, one of the forefathers of sociology and social psychology, was a French judge around the turn of the century who kept an analytical eye on trends in his society as represented by the legal cases that came before his court. Tarde observed certain generalizations about the diffusion of innovations that he called "the laws of imitation," and this became the title of his influential book, which was published in 1903. The purpose of his scholarly observations, Tarde (1903, p. 140) said, was 'to learn why, given one hundred different innovations conceived of at the same time—innovations in the form of words, in "mythological ideas, in industrial processes, etc.—ten will spread abroad while ninety will be forgotten."

Gabriel Tarde was undoubtedly an intellectual far ahead of his time in his thinking about diffusion. Even though he used slightly different concepts from those employed in the present book (for example, what Tarde called "imitation" is today called the "adoption" of an innovation), this sociological pioneer was on to several of the main research issues that were to be pursued by diffusion scholars in later decades, using more quantitative approaches. For example, as the above quotation indicates, Tarde identified the adoption or rejection of innovations as a crucial research question. He observed that the rate of adoption of a new idea usually followed an s-shaped curve over time. At first, only a few individuals adopt a new idea, then the rate of adoption spurts as a large number of individuals accept the innovation, and finally the adoption rate slackens. Very astutely, Tarde recognized that the "take off" in the s-curve of adoption began to occur when the opinion leaders in a system used the new idea. So diffusion network thinking was involved in Tarde's explanation of the s-curve, even though he did not use such present-day concepts as networks, homophily, and heterophily. For example, Tarde (1969, pp. 29-30) observed that an innovation is first adopted by an individual who is socially closest to the source of the new idea, and that it then spreads gradually from higher-status to lower-status individuals. Further, Tarde (1969, p. 27) proposed as one of his most fundamental "laws of imitation" that the more similar an innovation is to those ideas that have already been accepted, the more likely the innovation is to be adopted (we discussed in Chapter 1 that the perceived compatibility of an innovation is related to its rapid rate of adoption).

To Gabriel Tarde, the diffusion of innovations was a basic and fundamental explanation of human behavior change: "Invention and imitation are, as we know, the elementary social acts" (Tarde, 1969, p. 178). So Tarde was one of the European grandfathers of the diffusion field. But his creative insights were not followed up immediately by empirical studies of diffusion. That was not to happen until after a lapse of almost forty years. Perhaps social scientists of Tarde's day lacked the methodological tools to mount diffusion studies; maybe they were just not inclined to follow up on his leads. In any event, his suggested approach to diffusion research lay fallow for several decades, until an invisible college of American scholars was to coalesce around Tarde's "laws of imitation." — "

The British and German-Austrian Diffusionists

Another root in the ancestry of diffusion research was a group of early anthropologists that evolved in England and in Germany-Austria soon after the time of Gabriel Tarde in France (although they were not influenced by his writings). These anthropologists are called the "British diffusionists" and the "German-Austrian diffusionists." The viewpoint of each group was similar. Diffusionism was the point

of view in anthropology that explained change in a given society as a result of the introduction of innovations from another society. The diffusionists claimed that all innovations spread from one original source, which, of course, argued against the existence of parallel invention (today we know that such parallel invention of new ideas has frequently occurred in history).

The diffusionism viewpoint does not have much of a following today, owing to the extreme claim of the diffusionists that all social change could be explained by diffusion alone. The dominant viewpoint now is that social change is caused by both invention (the process by which a new idea is discovered or created) and diffusion, which usually occur sequentially. Viewed in retrospect, we see that the main contribution of the European diffusionists was in their calling the importance of diffusion to the attention of other social scientists (Kroeber, 1937, pp. 137-142). The diffusionists would have had greater impact if they had not so overstated their case.

The scholars who picked up on the work of the European diffusionists most directly, as one might expect, were anthropologists, especially those in the United States who, beginning in the 1920s, began to investigate the diffusion of innovations.

The Rise of Diffusion Research Traditions

The anthropological diffusion researchers constitute the oldest of the nine diffusion research traditions.* In the following sections of this chapter we shall trace the intellectual ancestry of each of these nine traditions, as they help us to understand the history of diffusion research. Each research tradition consists of an academic discipline (for example, anthropology, marketing, geography) or a subdiscipline (for instance, early sociology, rural sociology, medical sociology). Each tradition usually has concentrated on investigating the diffusion of one main type of innovation: for example, rural sociologists have specialized in farm innovations. Table 2-1 shows, for each tradition,

* The exact number of major diffusion research traditions is, of course, somewhat arbitrary. We chose these nine because they represent the relatively greatest number of empirical diffusion publications (an exception is the early sociology tradition, which is included because of its considerable influence on most of the other traditions which develop later). The nine traditions represent a total of 2,585 of the 3,085 publications available in late 1981, or 84 percent of the total diffusion reports then available.

the main types of innovations studied, methods of data gathering and analysis, the unit of analysis, and the types of findings. This overview and comparison of the nine diffusion research traditions is complemented by the following narrative description of each tradition.

Paradigms and Invisible Colleges

Any given field of scientific research begins with a major breakthrough or reconceptualization, called a "revolutionary paradigm" by Kuhn (1970), that provides a new way of looking at some phenomenon. A *paradigm* is a scientific approach to some phenomena that provides model problems and solutions to a community of scholars. Recognition of a new paradigm typically sets off a furious amount of intellectual effort as promising young scientists are attracted to the field, either to advance the new conceptualization with their research or to disprove certain of its aspects. Gradually, a scientific consensus about the field is developed, and, perhaps after several generations of academic scholars, the *invisible college* (an informal network of researchers who form around an intellectual paradigm to study a common topic) declines in scientific interest as fewer findings of an exciting nature are turned up. (We show the invisible college of rural sociologists studying diffusion later in this chapter, in Figure 2-2.) These are the usual stages in the normal growth of science, Kuhn (1970) claims. The research process is a very social activity in which crucial decisions are influenced by a network of scientists, who are organized around one important research idea.

As Abraham Kaplan (1964, p. 28) stated in his important book on research methods, "Give a small boy a hammer, and he will find everything he encounters needs pounding." Most scientists in any field are much like Kaplan's little boy; in deciding which research problem to study and exactly how to study it, they face uncertainty. In behavior parallel to that of the potential adopters of an innovation, scientists rely on the subjective experiences of their peers. An invisible college centered in an intellectual paradigm provides the typical scientist with the information he or she needs to reduce the uncertainty of the research process. Of the many alternative directions that a research project might pursue, a paradigm structures a researcher toward one general approach. Thus, the paradigm and the invisible college of scientists that follow the paradigm provide a researcher with a source of security and stability in the uncertain world of research.

Table 2–1. Comparison of the Nine Major Diffusion Research Traditions.

Diffusion Research Tradition	Number of Diffusion Publications	Typical Innovations Studied	Method of Data Gathering and Analysis	Main Unit of Analysis	Major Types of Findings
1. Anthropology	134	Technological ideas (steel ax, the horse, water boiling)	Participant and nonparticipant observation and the case study approach	Tribes or peasant villages	Consequences of innovations; relative success of change agents
2. Early sociology	10	City manager government, postage stamps, ham radios	Data from secondary sources and statistical analysis	Communities or individuals	S-shaped adopter distribution; characteristics of adopter categories
3. Rural sociology*	791	Mainly agricultural ideas (weed sprays, hybrid seed, fertilizers)	Survey interviews and statistical analysis	Individual farmers in rural communities	S-shaped adopter distribution; characteristics of adopter categories; perceived attributes of innovations and their rate of adoption; communication channels by stages in the innovation-decision process; characteristics of opinion leaders
4. Education	336	Teaching/learning innovations (kindergartens, modern math, programmed instruction, team teaching)	Mailed questionnaires, survey interviews, and statistical analysis	School systems, teachers, or administrators	S-shaped adopter distribution; characteristics of adopter categories
5. Public health and medical sociology	226	Medical and health ideas (drugs, vaccinations, family planning methods, CAT scanner)	Survey interviews and statistical analysis	Individuals or organizations like hospitals	Opinion leadership in diffusion; characteristics of adopter categories; communication channels by stages in the innovation-decision process
6. Communication	372	News events, technological innovations	Survey interviews and statistical analysis	Individuals or organizations	Communication channels by stages in the innovation-decision process; characteristics of adopter categories, and of opinion leaders; diffusion networks
7. Marketing	304	New products (a coffee brand, the touch-tone telephone, clothing fashions)	Survey interviews and statistical analysis; field experiments	Individual consumers	Characteristics of adopter categories; opinion leadership in diffusion
8. Geography	130	Technological innovations	Secondary records and statistical analysis	Individuals and organizations	Role of spatial distance in diffusion
9. General sociology	382	A wide variety of new ideas	Survey interviews and statistical analysis	Individuals	Characteristics of adopter categories; various others.
10. Other traditions†	500	—	—	—	—
Total	3,085				

*The rural sociology tradition actually includes 147 publications by diffusion scholars in extension, whose work is closely related.

†Includes general economics, political science, agricultural economics, psychology, statistics, industrial engineering, and various others.

Source: Diffusion Documents Center, Stanford University, in 1981.

Research on the diffusion of innovations followed these rise-and-fall stages rather closely (Crane, 1972), although the final stage of demise does not seem to have begun. The hybrid corn diffusion study by Bryce Ryan and Neal Gross (1943), described in Chapter 1, set forth a new approach to the study of diffusion,* that was soon followed up by an increasing number of scholars. Within ten years (by 1953), over 146 diffusion researches were completed; during the next decade (by 1963), another 647; and by 1973, another 1,417. In 1981 there were over 3,085 publications about the diffusion of innovations, including about 2,297 empirical research reports and 788 other writings (Figure 2-1). Thus, we see that the amount of scientific activity involved in investigating the diffusion of innovations has increased at a very sharp rate since the revolutionary paradigm appeared about forty years ago, as Kuhn's (1970) theory of the growth of science would predict.

Diffusion research is a particular type of communication research (as we explained in Chapter 1), but it began outside of the academic field of communication. Mostly this was a matter of timing, as for example, the Ryan and Gross (1943) hybrid corn study preceded the first university centers or departments of communication by about ten years. The diffusion research approach was taken up in a variety of fields: education, anthropology, medical sociology, marketing, geography, and in rural sociology. Each of these disciplines pursued diffusion research in its own specialized way, and for some time without much interchange with the other diffusion research traditions, at least until the early 1960s when the boundaries between the traditions began to break down.

But before we describe this intellectual integration in the 1960s, we must return to the beginnings of the anthropological research tradition on diffusion, in the 1920s.

The Anthropology Research Tradition

The anthropology tradition is not only the oldest of the nine traditions analyzed in this book, it is also the most distinctive in its methodolog-

* Perhaps some question might be raised as to whether formulation of the diffusion approach truly constituted a paradigm, or only a "quasi-paradigm." The diffusion conceptualization was distinctive in the social sciences at the time of its formulation in the 1940s, and it certainly set off a great number of following researches. So it seems to meet our definition of a paradigm. But certainly the diffusion paradigm was not as revolutionary as Copernicus' astronomy, Newtonian physics, Darwin's evolution, or Einstein's theory of relativity. In comparison with these great ideas of science, the diffusion model is but a mini-paradigm.

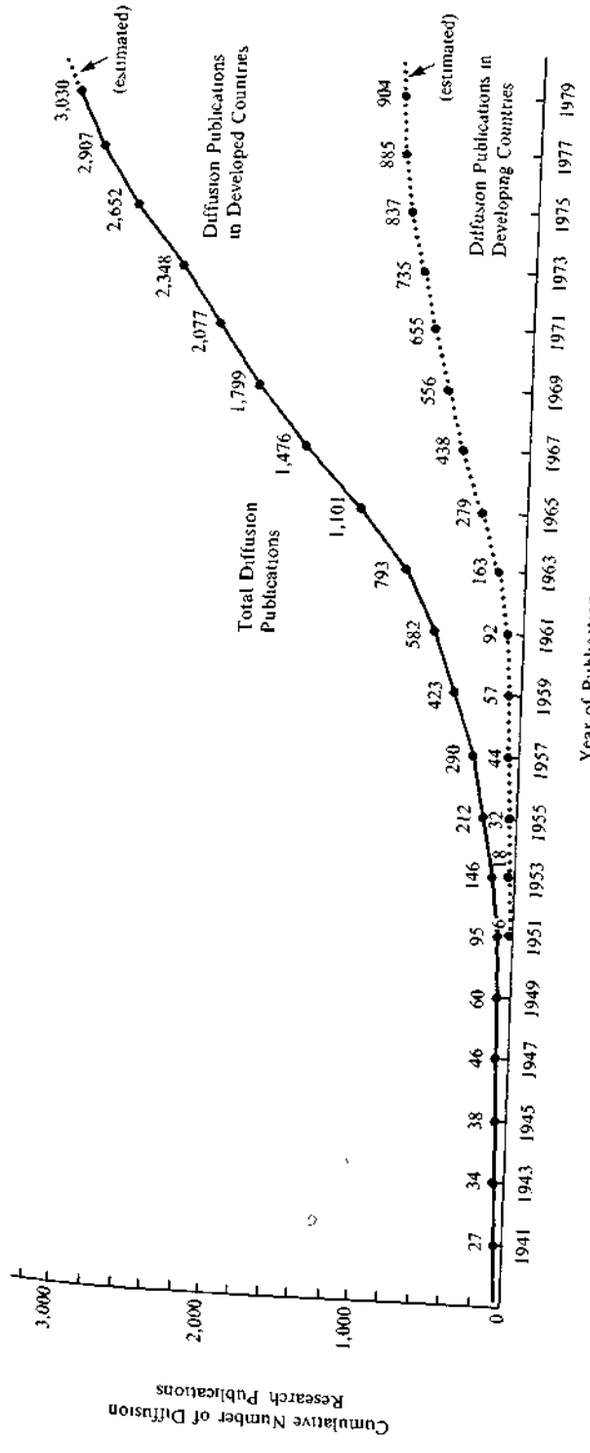

Figure 2-1. Cumulative number of diffusion research publications by year.

The field of research on the diffusion of innovations took off after formation of the diffusion paradigm by Ryan and Gross (1943). In each succeeding two-year period, the number of diffusion publications has increased considerably, until the late 1970s when our data on the number of publications are only approximate due to the lag in obtaining those publications. We also show here the number of diffusion research publications in developing versus developed countries; the former represent about 30 percent of all diffusion publications today, while about 70 percent have their setting in developed nations.

Source: Diffusion publications available in 1981.

ical approach to studying diffusion. As a rule, most anthropologists are taught by their mentors to distrust numbers as a basis for describing and analyzing social behavior. The quantitative approach, based as it necessarily is on a social scientist learning "a little about a lot," is anathema to the anthropologist who strongly prefers to learn "a lot about a little." This point of view means that the anthropologist who studies diffusion usually prefers to avoid using such tools as personal interviews, random sample surveys, and computer data-analysis. In fact, such "number crunching" with a computer is abhorrent to most anthropologists.

Anthropologists prefer to gather diffusion data more directly from their respondents, by means *of participant observation,* a commitment by a researcher to adopt the perspective of the respondents by sharing their day-to-day experiences. In order to get into his or her subjects' skins, an anthropologist often goes to live among them, seeking to empathize into their everyday roles. Obviously, such a total-immersion approach requires a great deal of patience on the part of the anthropologist field researcher, who may have to wait for a long time indeed for what he or she has come to observe (such as diffusion and adoption behavior) to occur. The participant-observation method not only requires a long time for data gathering (anthropologists often live among their respondents for several years), it also means that anthropologists are limited to studying diffusion in rather tiny systems, often a single village. Most anthropological research is a one-person operation, and the investigator is therefore limited to what he or she can observe in a limited setting. The results of such inquiry provide valuable insights into the microscopic details of diffusion and adoption. But one cannot be very certain that the results of anthropological diffusion studies are generalizable. For instance, to what extent can the administrators of the public health service in Peru apply the findings from Wellin's (1955) anthropological investigation of the failure of the water-boiling campaign in Los Molinos (described in Chapter 1): to other Peruvian villages? Does Los Molinos have special characteristics that affected the adoption and rejection of water boiling? Would similar diffusion problems occur in other Peruvian villages? We do not know.

There are, however, several special advantages of anthropological research on diffusion. For one thing, if the anthropologist is successful in his or her attempt to empathize with the respondents of study, the ensuing account of diffusion will tell the story from the respondents' viewpoint, conveying their perceptions of the innovation

and of the change agency with an in-depth understanding that other social scientists can seldom match. This perspective helps the anthropologist overcome the pro-innovation bias of most other diffusion researchers. If anything, anthropologists sometimes seem to display an inclination toward anti-innovation. Through total immersion in the respondents' system, the anthropologist gains a holistic perspective of the lifestyles, world views, and social relationships of the respondents. This capacity of anthropologists to understand the total culture of their individuals of study, coupled with their over-time data gathering, provides the anthropological diffusion scholars with a unique means of understanding the consequences of innovation. It is no accident that much of the research featured in our Chapter 11 was carried out by anthropologists.

In addition to their useful contributions to our understanding of consequences, a good deal of anthropological research also has been conducted on the relationship of an innovation's compatibility with cultural values, to the innovation's rate of adoption.* In many of their research accounts, anthropologists show that the planners and officials in charge of development programs failed to account fully for the cultural values of the expected adopters of an innovation. As a result, the diffusion program often failed, or at least it led to unanticipated consequences.

Compared to other research traditions, anthropology has been more concerned with the transfer of technological innovations from one society to another (as compared to the diffusion of a new idea within a society or system). This emphasis on cross-cultural diffusion is consistent with anthropologists' interest in the concept of culture, one of their favorite intellectual tools. An early illustration of this type of investigation was Wissler's (1923, pp. 111-121) study of the diffusion of horses from Spanish explorers to American Indian tribes. More contemporary studies of cross-cultural diffusion in the anthropological diffusion tradition comprise research that evaluates the effectiveness of development programs in which Western technologies are introduced in the developing countries of Latin America, Africa, and Asia.

In part owing to their early appearance on the diffusion research scene, anthropologists have influenced the other eight diffusion

Summaries of anthropological evidence on this point are provided by Spicer (1952), Barnett (1953), Arensberg and Niehoff (1964), and Niehoff (1966). Linton (1936, PP. 324-336) was one of the first scholars to recognize the relationship of the perceived characteristics of an innovation to its rate of adoption.

research traditions, particularly early sociology and rural sociology. The other traditions have seldom used participant observation as their data-gathering methodology, but they have carried forward into quantitative research certain of the theoretical leads pioneered by anthropology diffusion scholars.

Early Sociology

The intellectual tradition that we refer to as "early sociology" traces its ancestry to the French sociologist Gabriel Tarde, but most of the research publications in this tradition appeared from the late 1920s to the early 1940s (about the same time that the anthropology diffusion tradition was getting under way). The social significance of the early sociology tradition lies neither in its volume of investigations (there are only ten) nor in the sophistication of its research methods but in the considerable influence of early sociologists upon later diffusion researchers.

Most early sociologists traced the diffusion of a single innovation over a geographical area like a state or a region. The motivating interest of the early sociologists was primarily in the diffusion of innovations that contributed to social change. With the exception of Bowers (1937; 1938), who investigated the diffusion of ham radio sets, early sociologists did not emphasize the innovation-decision process nor did they concentrate upon the process by which opinion leaders influenced others in their system to adopt or reject a new idea.

Bowers' (1937; 1938) investigation was probably the first study in the early sociology tradition that used primary data from respondents, in addition to data from secondary sources like government records. He contacted a sample of 312 ham-radio operators in the United States by mailed questionnaire in order to determine the influences that led to their adoption of the radios. Bowers (1938) was the first researcher to find that interpersonal channels are more important than mass-media channels for later adopters than for earlier adopters. The number of amateur radio operators in the United States had increased sharply from about 3,000 in 1914 to 46,000 in 1935, and Bowers determined that this adopter distribution followed an s-shaped normal curve when the number of adopters were plotted by year. Bowers also related such ecological factors as city size and region in the United States to the rate of adoption of ham radios. Like others in the early sociology tradition, Bowers thus correlated ecological factors to innovativeness.

The ten studies in the early sociology diffusion tradition differed from their anthropological counterparts in that they used quantitative data analysis, a methodological approach that was to be followed by other research traditions. But the intellectual paradigm that was to set off widespread research on the diffusion of innovations had not yet happened. Creation of this paradigm had to wait for the rural sociology tradition.

Rural Sociology

The research tradition that can claim major credit for initially forming the intellectual paradigm for diffusion research, and that has produced the largest number of diffusion studies and over the longest period of years, is rural sociology. Dominance of the diffusion field by rural sociology, however, as indexed by the percentage of all diffusion studies that were completed by rural sociologists, has declined over the past twenty years as other diffusion research traditions have grown more rapidly in size. Up to 1964, 423 of the 950 diffusion publications (45 percent) were in the rural sociology tradition. From 1965 to 1969, only 225 (26 percent) of the 849 diffusion publications were in rural sociology, and this percentage dropped further, to 14 percent (100 of 708 diffusion publications) from 1970 to 1974. Finally, since 1974, only 8 percent (45 of 578 publications) of all diffusion studies are in rural sociology. Today the rural sociology tradition no longer hogs the field of diffusion research; this tradition has faded in both its relative and absolute role in the diffusion field. But 791 of the 3,085 diffusion publications available in 1981 (26 percent) were by rural sociologists. Table 2-2 shows that rural sociology is still number one in its share of all diffusion studies. Perhaps it is a healthy sign that diffusion research is becoming more multidisciplinary.

Rural sociology is a subfield of sociology that focuses on the social problems of rural life. Most rural sociologists are employed by land-grant universities in colleges of agriculture. These agriculture schools have three main functions: (1) to teach students, (2) to conduct research on agricultural problems, so as to help farmers and agricultural businesses, and (3) to operate a state extension service to diffuse the agricultural innovations (coming from research) to potential adopters, mainly farmers. The state colleges of agriculture and their research and extension subunits, the state agricultural experiment stations, and the state agricultural extension services are dominated by administrators and scientists specializing in agricultural production

Table 2-2. Major Diffusion Research Traditions.

Diffusion Research Tradition	Number of Diffusion Publications	Percentage of All Diffusion Publications in This Tradition	Percentage of All Diffusion Publications in This Tradition that was Completed in Developing Countries	Historical Trends in the Tradition
1. Rural sociology*	791	26	37	The dominant research tradition until about 1964, and with considerable diffusion research conducted until about 1972, but with relatively little research conducted after that date, especially in developing countries.
2. Communication	372	12	55	This tradition got under way in the early 1960s; it is important in developing nations.
3. Education	336	11	6	Largely consisted of the work of Dr. Paul Mort and his students until the early 1960s, when this tradition expanded rapidly, but it slowed again after the mid-1970s.
4. Marketing†	304	10	2	A major research tradition after the early 1960s in the United States.
5. General sociology ≡	282	9	22	Some publications were completed in the 1950s, and the tradition slowly grew in importance in the 1960s and 1970s.
6. Public health and medical sociology	226	7	47	This tradition really got underway in the 1960s, both in developing nations and the United States, especially with studies of the diffusion of family planning innovations.
7. Anthropology	134	4	60	A pioneering tradition with a modest number of publications completed each year.
8. Geography	130	4	16	After the creative approach to diffusion simulation by Dr. Torsten Hägerstrand in the early 1950s, this tradition began to grow in the U.S. after the mid-1960s.
9. Early sociology	10	(less than 1)	—	Pioneering research leading to the diffusion paradigm, conducted prior to 1940.
10. Other traditions ◊	500	17	—	
Totals	3,085	100	30	

*The rural sociology tradition includes 147 publications (19 percent of the total) by diffusion scholars in extension, whose work is closely related.

†This tradition includes publications by scholars affiliated with business schools, which may not all follow a strict marketing approach.

≡ This tradition is somewhat of a residual category in that it consists of publications by sociologists who are not early sociologists, rural sociologists, or medical sociologists.

◊ Includes (1) general economics (3 percent of diffusion publications), (2) political science (3 percent), (3) agricultural economics (3 percent), (4) psychology (2 percent), (5) statistics (1 percent), (6) industrial engineering (1 percent), and (7) various others (4 percent).

Source: Diffusion publications available in 1981.

fields (for example, crop growing, milk production, beef farming, and horticultural production). In such an organization, where the main value is on raising farm production, most of the activities of rural sociologists are considered rather superfluous by the agricultural scientists who run the state colleges of agriculture.

Except for diffusion research. It can provide helpful leads to agricultural researchers about how to get their scientific results put into use by farmers. And diffusion research is greatly appreciated by extension service workers, who depend on the diffusion model as the main theory guiding their efforts to transfer new agricultural technologies to farmers (Rogers et al, 1982a). So diffusion research fits well with the heavy value on agricultural production that dominates colleges of agriculture. Other research by rural sociologists on such important social problems as the increase in rural crime rates, the decrease in farm population through migration to cities, and rural health problems, is not so well appreciated by the agricultural biologists who run state colleges of agriculture. Under these organizational conditions, it is not surprising that the diffusion of agricultural innovations became a popular research topic among rural sociologists.

THE HYBRID CORN STUDY

Although a couple of diffusion studies had been completed during the 1920s and 1930s, the Ryan and Gross (1943) investigation of the diffusion of hybrid-seed corn, more than any other study, influenced the methodology, theoretical framework, and interpretations of later students in the rural sociology tradition, and in other research traditions as well. Dr. Bryce Ryan was a professor of rural sociology at Iowa State University, the state land-grant school at Ames. In 1941, he convinced the Iowa Agricultural Experiment Station (the research branch of the college of agriculture) to fund his proposed investigation of the spread of hybrid seed to Iowa farmers. This innovation was something of a success story for Iowa State University. The development of hybrid seed corn had resulted from twenty years of genetic research by agricultural scientists at Ames; finally, in 1928 hybrid seed was made available to Iowa farmers, promoted by the Iowa Agricultural Extension Service and by the commercial seed companies that marketed the seed. As was pointed out in Chapter 1, the hybrid vigor of the new seed typically increased corn yields on Iowa farms by about 20 percent, hybrid corn varieties withstood drought better than the

open-pollinated seed they replaced, and hybrid corn was better suited to harvesting by mechanical corn pickers. Corn was the main farm crop in Iowa in the 1930s; in fact, Iowa's official state song bills it as "the tall corn state." It is no surprise that under these conditions, the hybrid seed was adopted rapidly. By 1941, about thirteen years after its first release, the innovation was adopted by almost 100 percent of Iowa farmers.

Presumably, administrators in the Iowa Agricultural Experiment Station sponsored Professor Ryan's diffusion study because they wanted to improve their understanding of this case of successful diffusion in order to learn lessons that might be applied to the diffusion of future farm innovations. These officials may also have been puzzled and frustrated as to why such an obviously advantageous innovation as hybrid corn was not adopted more rapidly. They wondered, for example, why some farmers waited thirteen years to adopt, a period during which they were surrounded by neighbors who were using the innovation successfully.

In the summer of 1941, Neal Gross, a new graduate student in rural sociology, was hired by Professor Ryan as a research assistant on the hybrid corn diffusion project. They selected two small Iowa communities, located to the west of Ames, and proceeded to interview personally all of the 259 farmers living in the two systems. Using a structured questionnaire, Neal Gross, who did most of the data gathering, interviewed each respondent about when he decided to adopt hybrid corn (the year of adoption was to become the main dependent variable in Ryan and Gross' data analysis), the communication channels he had used at each stage in the innovation-decision process, and how much of his corn acreage he had planted in hybrid (rather than open-pollinated) seed each year. In addition to these recall data about the innovation, the rural sociologists also asked each respondent about his formal education, age, farm size, income, travel to Des Moines and other cities, readership of farm magazines, and other variables that were later to be correlated with innovativeness (measured as the year in which each farmer decided to adopt hybrid corn).

When all the data were gathered, Ryan and Gross converted the farmers' interview responses into coded form (that is, to numbers). These diffusion researchers analyzed the data by hand tabulation and with a desk calculator (the use of a computer for data analysis did not begin until about fifteen years later). Within a year, Neal Gross (1942) completed his Master's thesis on the diffusion of hybrid corn, and shortly thereafter Ryan and Gross (1943) published an article out of

the study in the journal, *Rural Sociology* (this article is the most widely cited publication out of the study, although there are several others).

We described the main findings from the hybrid corn study in Chapter 1, and there is no need to repeat them here. This classic diffusion study headed later diffusion scholars toward pursuing certain research questions such as: what variables are related to innovativeness? What is the rate of adoption of an innovation, and what factors (like the perceived attributes of the innovation) explain this rate? What role do different communication channels play at various stages in the innovation-decision process? These research directions have continued to dominate almost all diffusion research since 1943. The intellectual influence of the hybrid corn study reached far beyond Iowa, the study of agricultural innovations, and even outside the rural sociology tradition of diffusion research. The research paradigm created by the Ryan and Gross investigation became the academic template that was to be mimicked, first by other rural sociologists in their agricultural diffusion researches, and then by almost all other diffusion research traditions (whether they knew it or not).

The Iowa hybrid corn study has left an indelible stamp on the field of diffusion research up to the present. This lasting influence is not completely beneficial, intellectually speaking. An overly close copying of the classical diffusion paradigm by later researchers, who were often investigating diffusion of a quite different type, led to inappropriate methodologies and mistaken theoretical thrusts. Criticisms such as these, caused by the dominance of the classical paradigm, are discussed in Chapter 3. We argue that the overwhelming relative advantage of hybrid corn (over open-pollinated seed) may have contributed to both the pro-innovation bias of later diffusion studies and to the lack of research attention paid to the consequences of technological innovations. Because the effects of hybrid corn were so obviously beneficial, it was easy to assume that the consequences of other innovations would also be positive.

In addition to structuring the diffusion paradigm theoretically, the Ryan and Gross hybrid corn study also established a prototypical methodology for going about a diffusion investigation: one-shot survey interviews with the adopters of an innovation, who were asked to recall their behavior and decisions regarding the innovation. Thus, the typical research design for studying diffusion was established in 1941. It has lived on, with only rare and minor modifications, to the present day. The alternate methodological paths that were not taken by diffusion scholars represent a shortcoming in the field today.

THE INVISIBLE COLLEGE OF RURAL SOCIOLOGY DIFFUSION RESEARCHERS Is FORMED

During the 1950s, an explosion occurred in the number of diffusion studies by rural sociologists. Important pioneers in this tradition were (1) Dr. Eugene A. Wilkening, who moved to the University of Wisconsin in the early 1950s after several years of excellent diffusion studies in North Carolina, and (2) Dr. Herbert F. Lionberger of the University of Missouri. A third center of research and training in agricultural diffusion was at Iowa State University where Professors George M. Beal and Joe M. Bohlen carried forward the diffusion studies launched by Ryan and Gross. New Ph.D.s in rural sociology, produced at Madison, Columbia, and Ames in the 1950s, then became professors of rural sociology at other state land-grant universities where they, in turn, established diffusion research programs. In fact, I was one of these diffusion research missionaries.

Crane (1972, p. 188) studied the invisible college of diffusion researchers in the rural sociology tradition in the mid-1960s, and concluded that it was a highly interconnected network of scholars who shared a common theoretical-methodological framework. Dominating the network were two large cliques,* one composed of twenty-seven scholars and the other of thirty-two researchers; each centered in a leading scholar of diffusion whose network links reached out to former Ph.D. students and to the students of those students. Smaller cliques of thirteen, twelve, seven, etc. scholars were highly connected to the two major cliques (Figure 2-2). This communication structure of the network of rural sociology diffusion researchers provided consensus and coherence to the field; it meant that these scholars shared a common framework in studying diffusion, and that they were kept abreast of each others' research findings. This helped the field to progress in an ordered direction toward its research goals. There was a cumulative nature to these research directions, as each study built upon the accomplishments of previous work. Unfortunately, it also meant that radical deviations from the diffusion paradigm were implicitly discouraged or stultified. Some of the reality of diffusion was ignored, because it was not part of the accepted diffusion paradigm.

Another key factor in the 1950s-1960s proliferation of the rural sociology diffusion research tradition, in addition to the interconnectedness of the invisible college of scholars, was the availability of

A *clique* is a subsystem whose elements interact with each other relatively more frequently than with other members of the communication system.

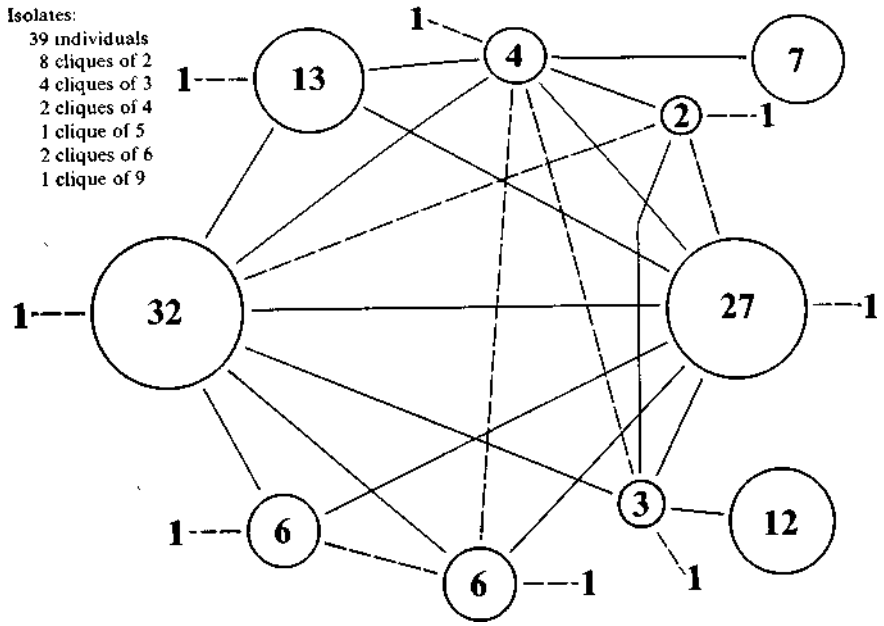

Figure 2-2. Communication network structure of rural sociologists studying diffusion as of 1967, on the basis of their collaboration.

The invisible college of rural sociologists studying diffusion was relatively interconnected in 1967 when Crane gathered these network data by mailed questionnaire from the 221 scholars in this diffusion research tradition. The cliques shown here were identified by a network-analysis computer program so that each clique included individuals who interact more frequently with each other than with others. For the sake of simplicity, we have not shown the links within each clique, nor have we shown isolates in the sociogram. Direct collaboration between individuals in a pair of cliques is shown as a solid line, and a broken line indicates indirect collaboration (indicating that any member of a clique is linked to an individual in another clique through someone else). The two largest cliques, containing twenty-seven and thirty-two researchers, respectively, provide connectedness to the entire invisible college; if they were removed, the network would tend to decompose. The four largest cliques include all eight of the "high producers" (each of whom had ten or more diffusion publications); most of the clique members were their collaborators or students. All eight high producers were in communication with one another about current research. As in other invisible colleges that have been studied, the most productive scientists are leaders of cliques, and their contacts with each other link the cliques into a network. However, 101 of the 221 researchers are isolates or members of cliques not connected to the rest of the network. Few of these 101 individuals are productive scholars; many just completed their Master's or Ph.D. theses but had no further publications. Some do not live in the United States, having returned to their home country after finishing graduate study in America.

Source: Based on data reported by Crane (1972, p. 188).

research funds. During this period, the state agricultural experiment stations, together with the U.S. Department of Agriculture which partially funds the state agricultural research, were producing a tremendous outpouring of farm innovations: weed sprays, chemical fertilizers, new crop varieties, chemical feeds for livestock, and new farm machinery. The result was an "agricultural revolution" in which the number of persons fed and clothed by the average American farmer shot up from fourteen in 1950, to twenty-six in 1960, to forty-seven in 1970. This rapid increase in agricultural productivity rested not only on the availability of farm innovations, but also on their effective diffusion to American farmers.

That is where the rural sociologists came in. Their diffusion studies helped show agricultural extension workers how to communicate these new technological ideas to farmers, and thus how to speed up the diffusion process. Thanks to Ryan and Gross (1943), the rural sociologists had an appropriate paradigm to guide their diffusion studies. Thanks to the agricultural revolution of the 1950s, these diffusion scholars were in the right place (state university colleges of agriculture) at the right time. The result was a proliferation of diffusion studies by the rural sociology tradition: 185 by 1960, 648 by 1970, and 791 by 1981.

RURAL SOCIOLOGY DIFFUSION RESEARCH IN DEVELOPING NATIONS

By the 1960s, American rural sociologists went international. This decade marked a large-scale attempt to export the land-grant university/agricultural extension service complex to the developing nations of Latin America, Africa, and Asia. With funding from the U.S. Agency for International Development (AID) and from private foundations, U.S. land-grant universities created overseas campuses in which American faculty members taught, conducted agricultural research, and advised extension services and other development programs (Rogers et al, 1982a). Rural sociologists were part of this overseas operation, and they (in collaboration with graduate students from these developing nations that they had trained) launched diffusion studies in peasant villages. Agricultural development was the main thrust of these international activities, so it was natural that the topic of diffusion of farm innovations should be pursued. In addition, rural sociologists branched out to investigate the diffusion of nutrihon, health, and family-planning innovations to villagers.

The early 1960s marked the beginning of a sharp take off in the number of diffusion studies in developing countries (Figure 2-1). Pioneering ventures in this direction by Syed A. Rahim (1961) in Bangladesh, and by Paul J. Deutschmann and Orlando Fals Borda (1962b) in Colombia, suggested that new ideas spread among peasants in villages in a generally similar pattern to their diffusion in more media-saturated settings like the United States and Europe. The diffusion process, and the concepts and models used to analyze it, seemed to be cross-culturally valid, at least in the sense that comparable results were found in the new settings. In later years, however, the applicability of the diffusion paradigm that was exported from the United States to developing nations, began to be questioned.

There were compelling reasons for the fast growth of diffusion studies in developing countries in the 1960s. Technology was assumed to be at the heart of development, at least as development was conceptualized at that time, so microlevel investigations of the diffusion of technological innovations among villagers were of direct relevance to development planners and other government officials in developing nations. These research results, and the general framework of diffusion, provided both a kind of theoretical approach to planning development programs and an evaluation procedure for measuring the success of development activities.

The number of diffusion researches in developing nations totaled only about 71 by 1960 (14 percent of all diffusion studies), but rose steeply to 601 in 1970 (31 percent of the total), and to 912 by 1981, when 30 percent of all diffusion studies had been conducted in Latin America, Africa, and Asia. By no means were all of these studies conducted by rural sociologists, but this tradition played a pioneering role in beginning diffusion research in developing nations (although since the mid-1970s, rural sociologists were conducting only a few diffusion studies in developing nations). In the 1970s, there began to appear criticisms of the diffusion paradigm as it was applied in Latin America, Africa, and Asia (which will be discussed in Chapter 3).

HARD TOMATOES AND HARD TIMES

During the 1970s some American rural sociologists began to question whether conducting research on the diffusion of agricultural innovations was indeed their most useful role, as social scientists of rural society. Such a questioning attitude was given a big boost by a radically critical book written by James Hightower (1972), *Hard Tomatoes, Hard Times: The Failure of America's Land-Grant College Complex.* The author used as a spectacular illustration the case of mechanized tomato harvesting, which required that farmers plant tomato varieties that are still very firm when they ripen. Both the harvesting machine and the hard tomato varieties were developed by agricultural researchers at state colleges of agriculture. One benefit of these innovations was cheaper tomato prices for the consumer, but unfortunately many consumers did not like the hard tomatoes. They expected ripe tomatoes to be soft. Indeed, the hard tomatoes contained somewhat fewer vitamins than the older, soft varieties. Further, the mechanized tomato harvesters put thousands of farm laborers out of work, and drove thousands of small farmers, who could not afford to buy the expensive harvesting machines, out of tomato production (the consequences of the tomato harvester are described in more detail in Chapter 4).

Hightower (1972) claimed that the state colleges of agriculture were responsible for the "agricultural revolution" in the United States through their development and diffusion of farm innovations, but that they had almost totally ignored the consequences of these technological innovations. Hightower said this technological irresponsibility amounted to a failure on the part of U.S. colleges of agriculture. This critical analyst showed that almost all of the professional resources of the publicly supported land-grant colleges went into (1) biological science, to develop innovations, and (2) agricultural extension service activities to diffuse these new ideas to farmers. This overemphasis on agricultural production technology meant that social science research on the consequences of innovation was severely shortchanged. Hightower's criticisms hit rural sociologists especially hard; they had been investigating diffusion for the past twenty years or so, in order to speed up the rate of adoption, instead of studying the consequences of technology and what could be done about the social problems stemming from the agricultural revolution in the United States.

While a number of useful diffusion studies continue to be conducted in the rural sociology tradition today, more attention is now being paid to investigating the consequences of agricultural technology (several of these researches will be discussed in Chapter 11). Further, some rural sociologists have become much more questioning of the emphasis placed upon agriculture production technology by colleges of agriculture. If the result is increased agricultural production in the United States at the cost of driving many farm families out of

agriculture, some rural sociologists wonder if colleges of agriculture are really serving the U.S. farmer. Some rural sociologists have become a kind of social conscience for U.S. colleges of agriculture. It is a quite different role from that played by the rural sociology tradition prior to about 1970. And this is one reason why the interest of rural sociologists in diffusion research has faded somewhat in recent years.

Education

Although it is an important diffusion research tradition in terms of the number of studies completed,* education is less important in terms of its contribution to the theoretical understanding of the diffusion of innovations. But there is an exciting potential contribution to be made by the education research tradition, stemming from the fact that organizations are involved, in one way or another, in the adoption of an educational innovation. Unlike U.S. farmers, who mainly make optional innovation-decisions, most teachers and school administrators are involved in collective and/or authority innovation-decisions. Teachers, unlike farmers, work in organizations.

THE TEACHERS COLLEGE STUDIES

A majority of early educational diffusion studies were completed at one institution, Columbia University's Teachers College, and under the direction of one man, Dr. Paul Mort. This tradition traces its roots to research in the 1920s and 1930s by Mort and others on local control over school financial decisions (as opposed to federal or state influence on these decisions), and on whether this local control led to school innovativeness. In short, the Columbia University education diffusion studies set out to show that local school control was related to innovativeness, which was thought to be a desirable characteristic of schools.

The data in these studies were most often gathered by question-

* Education diffusion publications numbered 23 in 1961 (5 percent of all diffusion work), 71 in 1968 (6 percent), and 336 in 1981 (11 percent of all diffusion publications). Education ranks third among the nine diffusion traditions in terms of number of publications (see Table 2-2).

naires mailed to school superintendents or principals.* The unit of analysis was the school system in almost all these investigations. The Columbia University diffusion studies found that the best single predictor of school innovativeness was educational cost per pupil. The wealth factor almost appeared to be a necessary prerequisite for innovativeness among public schools. One's stereotype of the rich suburban school in the United States as highly innovative, was largely confirmed by the early Teachers College studies. Further, Dr. Mort and his fellow researchers found that a considerable time lag was required for the widespread adoption of new educational ideas: "The average American school lags 25 years behind the best practice" (Mort, 1953, pp. 199-200).

There is, of course, a wide range in the rate of adoption of educational innovations. For instance, it took kindergartens about fifty years (from 1900 to 1950) to reach complete adoption by U.S. schools (Mort, 1953). But driver training needed only eighteen years (from 1935 to 1953) to reach widespread adoption (Allen, 1956), and modern math took only the five years from 1958 to 1963 (Carlson, 1965). Driver training and modern math were heavily promoted by change agencies: insurance companies and auto manufacturers in the case of driver training, and the National Science Foundation and the U.S. Department of Education in the case of modern math. The post-1958 aftermath of Sputnik caused public dissatisfaction with U.S. education and marked the beginning of an active federal government role in diffusing educational innovations. This recent involvement by federal and state-level governments in educational diffusion has somewhat eroded the degree of local school control which Mort had originally set out to show was so valuable.

LATER STUDIES ON EDUCATIONAL DIFFUSION

After Paul Mort's death in 1959, Teachers College of Columbia University lost its monopolistic control on educational diffusion. More recent studies focused (1) upon teachers as respondents, rather

* The financial support for these studies came largely from the public schools being studied. The total annual research budget for the Columbia University education diffusion investigations was over one-quarter million dollars in 1959. Most of this financial support was donated by an annual fee from each school that was studied; these schools were organized by Mort into research associations.

than simply on school administrators, (2) on within-school as well as school-to-school diffusion, and (3) on educational diffusion in developing nations. Many studies in the education tradition are sponsored by the U.S. Department of Education, as a means to evaluate the various diffusion programs that this government agency carries out. Many other diffusion studies are conducted by graduate students in education for their doctoral dissertations.

Two of the academic leaders in educational diffusion research are Dr. Ronald G. Havelock of American University and Dr. Matthew B. Miles of the Policy Research Institute in New York City; both have been engaged in diffusion research for over fifteen years, and each has written or edited a much-cited book (Miles, 1964; Havelock, 1969).

THE DIFFUSION OF MODERN MATH IN ALLEGHENY COUNTY

Probably the best piece of educational diffusion research is Dr. Richard O. Carlson's (1965) analysis of the spread of modern math among school administrators in Pennsylvania and West Virginia. He studied the opinion leadership patterns in the diffusion networks for modern math among school superintendents, variables correlated to innovativeness, perceived characteristics of innovations and their rate of adoption, and the consequences of one educational innovation: programmed instruction.

But Carlson's study is most impressive in the insight that it provides into the diffusion networks through which modern math spread from school to school in Allegheny County, Pennsylvania (this county is the metropolitan area for Pittsburgh). Carlson conducted personal interviews with each of the thirty-eight superintendents who headed these school systems, asking each (1) in what year they had adopted modern math, (2) which other superintendents were their best friends, and (3) for certain other data. Modern math entered the local educational scene of Allegheny County by means of one school superintendent, who adopted in 1958. This innovator traveled widely outside of the Pittsburgh area, but he was a sociometric isolate in the local network; none of the thirty-seven other school administrators talked with him. The s-shaped diffusion curve did not take off until 1959-1960 after a clique of six superintendents adopted; these six included the three main opinion leaders in the system. The rate of adoption then began to climb rapidly. There was only one adopter in 1958 (the innovator), five by the end of 1959, fifteen by 1960, twenty-seven by 1961, thirty-five by 1962, and all thirty-eight superintendents had adopted by the end of 1963. Thus, modern math spread to 100 percent adoption in about five years.

The cosmopolite innovator was too innovative to serve as an appropriate role model for the other superintendents. They waited to adopt until the opinion leaders in the six-member clique favored the innovation.

Carlson's focus on interpersonal networks in diffusion represented a step forward from the Ryan and Gross (1943) hybrid corn study, which failed to gather sociometric data. And the school superintendent study reminds one of the investigation of the diffusion of a new drug among medical doctors, carried out by the medical sociology tradition, which is discussed in the following section.

Public Health and Medical Sociology

This diffusion tradition began in the 1950s, about the same time that medical sociology began to be recognized as a field of sociological specialization.* The innovations studied are (1) new drugs or other new medical ideas, where the adopters are doctors, or (2) family-planning methods or health innovations, where the adopters are clients or patients.

COLUMBIA UNIVERSITY DRUG STUDY

The classic study in this tradition was completed by three sociologists: Elihu Katz, Herbert Menzel, and James Coleman, then of Columbia University. This investigation is perhaps second only to the Ryan and Gross analysis of hybrid corn in terms of its contribution to the diffusion paradigm. The most noted impact of the Columbia drug study was to orient future diffusion studies toward investigating the interpersonal networks through which subjective evaluations of an innovation are exchanged among individuals in a system. The drug study helped illuminate the nature of diffusion networks, suggesting the role

Although many diffusion researchers in the public health and medical sociology tradition do not necessarily identify themselves as "medical sociologists"; some are affiliated with university schools of public health, for example, and others with schools of medicine.

that opinion leaders played in the "take off" of the s-shaped diffusion curve.

The market research department of Charles Pfizer and Company, a large pharmaceutical firm in New York City provided a grant of about $40,000 to the Columbia sociologists for the project, which began in 1954. A pilot study of the spread of a new drug was carried out among thirty-three doctors in a New England town (Menzel and Katz, 1955). The main investigation was conducted, after methodological techniques had been pretested in the pilot study, in four cities in Illinois in late 1954.*

The drug study analyzed the diffusion of a new antibiotic that had appeared in late 1953. The innovation was referred to by the Columbia University researchers in most of their published reports by a pseudonym, "gammanym." The drug had been tried at least once by 87 percent of the Illinois doctors, who had been using two other closely related "miracle" drugs belonging to the same antibiotic family as gammanym. The new drug superseded an existing idea just as hybrid corn had replaced open-pollinated seed.

It is the patient rather than the doctor who pays for a new drug, although it is the doctor who makes the innovation decision. The Columbia University sociologists interviewed 125 general practitioners, internists, and pediatricians in the four Illinois cities. These were 85 percent of the doctors practicing in specialities where 'the new drug was of major potential significance" (Coleman et al, 1957). These 125 respondents sociometrically designated 103 additional doctors in other specialities who were also interviewed. Whereas many of the findings from the drug study are based upon the sample of 125 physicians, the sociometric analyses of diffusion networks come from the responses of the total sample of 228 doctors, which constituted 64 percent of all doctors in active private practice in the four cities (Coleman and others, 1957).

One of the neat methodological twists of the drug study was the use of an *objective measure* of time of adoption from the written record of drugstore prescriptions. The drug study is one of very few diffusion investigations in which the researchers were not forced to depend upon recall-type data on innovativeness. There was, in fact, a

The Illinois data are reported in Burt (1980), Menzel et al (1959), Coleman et al (1957, 1959, and 1966), Katz (1956, 1957, and 1961), Katz et al (1963), and Menzel (1957, 1959, and 1960). The present discussion features data mainly from the four Illinois cities, rather than from the pilot study in New England.

marked tendency for many doctors to report having adopted the drug earlier than their prescription records indicated (Menzel, 1957), although this might simply be because only a 10 percent sample of prescription records was consulted by the diffusion scholars.

The Columbia University investigators were not aware of other research traditions on diffusion at the time the gammanym data were gathered. The researchers make no secret of their surprise upon discovery of the hybrid seed study. Katz (1961) states: "The drug study was completed … without any real awareness of its many similarities to the study that had been undertaken by Ryan and Gross almost fifteen years before."

Actually, there were some striking parallels between the hybrid corn study and the drug study, given the considerable differences between farmers and physicians. For instance, innovative doctors attended more out-of-town medical meetings than did later adopters, reminding one of the innovative Iowa farmers who similarly displayed their cosmopoliteness by visiting Des Moines (later diffusion studies have also reported that innovators have friendship networks that extend outside of their local system). Just as the innovative Iowa farmers had larger farms and higher incomes, the innovative doctors served richer patients.

But the most important findings from the Columbia University drug study, as already noted, dealt with interpersonal diffusion networks. Coleman et al (1966) found that almost all of the opinion leaders, defined as the doctors who received three or more sociometric choices as social friends, had adopted gammanym by the eighth month (of the seventeen-month diffusion period that they studied). At about this point, the s-shaped diffusion curve for the opinion leaders' followers really took off. In other words, one reason for the s-shaped curve is that once the opinion leaders in a system adopt, they then convey their subjective evaluations of the innovation to their many network partners, who are thereby influenced to consider adopting the new idea.

Thus, a social system is a kind of collective-learning system in which the experiences of the earlier adopters of an innovation, transmitted through interpersonal networks, determine the rate of adoption of their followers. Such "learning by doing" in a social system could of course take a negative turn: if the new drug had not been very effective in curing the innovative doctors' patients, they would have passed their dissatisfactions with the new drug along to their peers.

Then the s-shaped diffusion curve would have displayed a much slower rate of adoption. Or it might have reached a plateau and declined as a result of widespread discontinuance.*

It is important to note that the doctors had plenty of information about the new drug. Gammanym had undergone clinical trials by pharmaceutical firms and by university medical schools prior to its release to doctors. The results of these scientific evaluations of the innovation were communicated in medical journal articles to the physicians in Coleman and others' (1966) sample, and by "detailmen" (employees of the drug firms who contacted the doctors with information about the new drug and who gave the doctors free samples of gammanym). These communication messages created awareness knowledge of the innovation among the medical community, but such scientific evaluations of the new drug were not sufficient to persuade the average doctor to adopt. Subjective evaluations of the new drug, based on the personal experience by a doctor's peers, were key to convincing the typical doctor to adopt its use with his own patients. When an office partner said to his colleague: "Look, doctor, I prescribe gammanym for my patients, and it cures them more effectively than other antibiotics," *that* kind of message often had an effect.

This important research finding by Coleman and others (1966) led the Columbia University sociologists to investigate which doctors talked to whom. A doctor could talk to any one of the several hundred other doctors in his community, but why did he choose the one, two, or three other doctors as friends? A dyadic network analysis disclosed that religion and age were the main determinants of friendship links, with home town and the medical school attended also of some importance. But the main reasons for who-to-whom links in the medical community were professional affiliations, such as belonging to the same hospital or clinic as another doctor or else participating with him or her in an office partnership. This finding suggested that the organizational affiliations of medical doctors played an important role in the diffusion of the medical innovation.

FAMILY PLANNING DIFFUSION IN DEVELOPING NATIONS

Since the classic investigation of drug diffusion, a considerable number of other diffusion studies have been completed in the public

* The rate of adoption for the IUD contraceptive reached a plateau in India as a result of negative rumors about the side effects of this innovation (Rogers, 1973, p. 300).

health and medical sociology tradition.* Only a few of these studies have dealt with the spread of new medical ideas to doctors; most are investigations of the adoption of health or family planning innovations by the public.

An important boost to the internationalization of the diffusion field was the rise of "KAP surveys" in developing countries during the 1960s. KAP studies are sample surveys of knowledge *(K),* attitudes *(A),* and practice *(P)* (that is, adoption) of family planning innovations. *K, A,* and *P* are the logical dependent variables in evaluations of family planning communication campaigns, and as national family planning programs arose after 1960 in many developing nations (at first in Asia, then in Latin America, and finally in Africa) to cope with the population problem, KAP-type diffusion researches blossomed on all sides. Over 500 such KAP surveys were conducted in 72 nations by 1973 (Rogers, 1973, p. 377); India alone represented the locale for over half of these investigations*.

With the exception of the Taichung experiment in Taiwan (Freedman and Takeshita, 1969), to be described shortly, the intellectual contribution of these KAP surveys "to scientific understanding of human behavior change has been dismal" (Rogers, 1973, p. 378). Although they may not have advanced the diffusion model very much, the KAP studies have served a useful function by generally showing that most parents in developing countries want fewer children than they actually have, and that the majority of the public desired a government family planning program. Even the harshest critic of KAP studies, Professor Philip H. Hauser (1967), stated that "KAP survey results, erroneous or not, have helped to persuade prime ministers, parliaments, and the general population to move in a desirable direction and have provided family planning program administrators with 'justification' for budgets and programs." So, the KAP surveys had an important impact on policy makers in developing nations, initially showing that national family planning programs were feasible, and later providing a means for evaluating the effectiveness of such programs.

*The number of public health and medical sociology diffusion publications increased from 36 in 1961 (7 percent of all diffusion publications), to 76 in 1968 (7 percent), to 226 in 1981 (7 percent); many of the recent studies in this tradition deal with family planning methods in developing nations.

*Many of these fugitive studies could not be obtained and thus are not included in our count of 226 publications in the public health and medical sociology tradition as of 1981.

Intellectually speaking, the family-planning diffusion studies were generally disappointing,* although several modifications in the classical diffusion model were formulated: the payment of incentives to promote the diffusion and adoption of contraception, the use of nonprofessional change agent aides, and the use of various communication strategies to help overcome the taboo nature of family planning. Such modifications in the classical diffusion model emerged when family-planning programs in developing nations found the classical model wanting (Rogers, 1973).

THE TAICHUNG FIELD EXPERIMENT

Family planning diffusion studies gave a boost to field experiment * research designs, as over a dozen such experiments in various nations have followed the Taichung study in Taiwan (Rogers and Agarwala-Rogers, 1975). This field experiment by Berelson and Freedman (1964)* was one of the earliest and most important of the KAP studies. Unlike the other KAP surveys, the Taichung study was a field experiment, that is, an experiment conducted in the "real world" rather than in the laboratory. In a field experiment, data are gathered from a sample of respondents at two points in time by means of a benchmark and a follow-up survey. Soon after the benchmark survey, a treatment (or treatments) is applied to the sample. The effects of the treatment can be determined by measuring the change in some variable (for instance, adoption of innovations) between the benchmark and the follow-up survey. One advantage of field experiment designs is that they allow the researcher to determine the *time order* of his independent (treatment) variable on the dependent variable. As such, field experiments are an ideal design for evaluating a diffusion program. The Berelson and Freedman study in Taiwan was one of the best, as well as one of the biggest: "This effort... is one of the most

* Particularly because of the unoriginal way in which the KAP studies were designed and conducted. For example, the independent variables related to *K, A,* and *P* were usually demographic variables like age, family size, formal education, and the like. It was as if the researchers who conducted the KAP surveys did not realize that diffusion is a particular type of communication process, in that mass media exposure and interpersonal networks were not given much attention in the KAP surveys (Rogers, 1973, pp. 379-389).

* A number of other publications report details on this research: Freedman (1964), Freedman and others (1964), Freedman and Takeshita (1965, 1969), Gillespie (1965), Takeshita (1964, 1966), and Takeshita et al (1964). All of these publications are summarized in Freedman and Takeshita (1969).

extensive and elaborate social science experiments ever carried out in a natural setting" (Berelson and Freedman, 1964).

The researchers implemented four different communication interventions in approximately 2,400 neighborhoods (each composed of twenty to thirty families) in Taichung, a city in Taiwan: (1) neighborhood meetings about family planning, (2) neighborhood meetings, plus mailed information about family planning to likely adopters, (3) neighborhood meetings, plus a personal visit to the home of likely adopters by a change agent who sought to persuade the women to adopt family planning, and (4) neighborhood meetings, plus personal visits by the change agent to both husband and wife in families likely to adopt. In addition, all of the 2,400 neighborhoods in Taichung were blanketed with family planning posters.

The results of this diffusion experiment were truly spectacular: 40 percent of the eligible audience of about 10,000 women adopted some form of family planning. Pregnancy rates immediately decreased by about 20 percent. Seventy-eight percent of the contraceptives adopted were lUDs, the main family planning method promoted in the experiment. The Taichung study showed that home visits by change agents were essential for the success of a family-planning program. Mass media communication (that is, the posters) created awareness-knowledge, but interpersonal communication led more directly to adoption of contraceptives. The Taichung researchers were surprised to find that considerable interpersonal diffusion occurred between their 2,400 neighborhoods of study and the rest of the city (which was considered their control group). This unplanned diffusion spoiled their neat experimental design, but it may have been their most important finding. Again, we see that interpersonal networks among near-peers energized the diffusion process.

The spectacular results of the Taiwan diffusion experiment provided optimism among development officials responsible for national family planning programs which were then initiated in many developing countries. In the years since the Berelson-Freedman study, however, it was impossible to secure results comparable to those achieved in Taiwan. So perhaps the Taiwan experiment led to an unrealistically rosy glow about family planning diffusion, an optimism that was to be dashed during the later 1960s and 1970s when many other nations launched family-planning programs. In fact, the experience of these programs to date suggests that contraceptives are one of the most difficult types of innovations to diffuse (Rogers, 1973) for reasons that we will discuss in Chapter 6.

But the general point made by the Taichung family-planning study is that diffusion researches need not be limited to conducting one-shot surveys of the adopters of an innovation, with data gathering soon after the new idea has diffused. A field experiment design allows a diffusion researcher to draw on diffusion theory in order to plan one or more communication interventions that can then be evaluated by analyzing data from benchmark and follow-up surveys. The results of diffusion field experiments can lead both to advancing our understanding of diffusion behavior, and to helping policy makers mount more effective diffusion programs.

Communication

The communication tradition of diffusion research ranked as the second largest (after the rural sociology tradition) by 1968, with eighty-seven diffusion publications (8 percent of the total). At the time of my 1962 book, *Diffusion of Innovations,* there were only five diffusion publications (1 percent of the total), and I did not even consider communication as a diffusion research tradition. The rapid growth of the communication tradition is shown by its position in 1981: 372 diffusion publications, 12 percent of the total, and ranking second (again to rural sociology) among the diffusion research traditions.

Diffusion research began before the academic field of communication research got underway. A focus on human communication as a scientific field of study was not fully appreciated until an influential book, *The Mathematical Theory of Communication,* was published by Claude E. Shannon and Warren Weaver (1949); these scholars identified the key concept of information and proposed a simple model of communication. Then the field of communication research, organized especially around studying the effects of mass communication, began to grow. At first, established scientists from political science, sociology, social psychology, and other social science fields were attracted to communication research. Soon, departments of communication were established at many universities, and began producing Ph.D.s in communication. These new scholars were often employed as professors in university departments of applied communication (such as journalism or advertising), and they helped inject an emphasis upon communication theory and research into the existing curricula.

Departments of journalism, speech, audiovisual education, advertising, and television and radio broadcasting had, of course, existed for many years. These departments mainly teach applied communication skills to undergraduates; they are primarily concerned with producing professional communicators. Professors in these academic settings realized that the training that they provide would be much more useful and more academically respectable if it were based on scientific research results and on communication theory. So they hired the new Ph.D.s in communication research.

One of the early concerns of communication researchers was the diffusion of news events carried by the mass media. Many such studies have been completed, dealing with such headline news items as Russia's launching of Sputnik, President Kennedy's assassination,* and natural disasters. News events diffuse in a generally similar fashion to technological innovations that have a material basis. The distribution of knowers over time follows an s-shaped curve, interpersonal and mass-media channels play comparable roles, and so on. One difference from the diffusion of other innovations is that news events spread much more rapidly; for example, 68 percent of the U.S. adult public was aware of the events in Dallas within thirty minutes of the shot that felled the president. Soon thereafter, almost everyone knew of this event.

In the early 1960s, communication researchers also began to investigate the transmission of technological ideas, especially agricultural, health, educational, and family-planning innovations in developing nations. Paul J. Deutschmann's study of the diffusion of innovations in a Colombian village* stands as a landmark and led to a focus of several communication researches upon peasant audiences in the 1960s. During the 1970s communication scholars began to investigate the diffusion of technological innovations in the United States, sometimes when communities or organizations were the adopting units (Chapter 10).

One of the special advantages of the communication research tradition is that it can analyze *any* particular type of innovation. There are no limitations, such as the education tradition's focus on educational innovations, the rural sociologist's main emphasis upon agri-

* Greenberg's (1964) analysis of the diffusion of the news of the Dallas assassination is somewhat typical of the approach used in the news event diffusion studies. Probably the most noted news event diffusion study, however, is by Deutschmann and Danielson (1960); it set the pattern for the other news diffusion studies that followed.

*The publications from this study are Deutschmann (1963), Deutschmann and Fals Borda (1962a,b), and Deutschmann and Havens (1965).

cultural ideas, or the medical sociologist's concern with family-planning methods. This lack of a message-content orientation perhaps allows the communication researcher to concentrate on the *process* of diffusion. Further, the communication tradition has an appropriate toolkit of useful concepts and methods (for example, credibility, network analysis, and the semantic differential) for studying diffusion. In fact, the enthusiastic way in which communication scientists have taken to diffusion research makes one wonder why they did not do so even sooner. The multidisciplinary backgrounds of communication research help this tradition integrate the work of various other diffusion research traditions.

Marketing

Another diffusion tradition that came on strong in the 1960s and especially in the 1970s, is marketing. Marketing managers of firms in the United States have long been concerned with how to launch new products most efficiently. Their interest in this topic is sparked by the regular launching of large numbers of new consumer products, many of which fail. For instance, it is estimated that only one idea out of every 540 results in a successful new product (Marting, 1964, p. 9). Only 8 percent of the approximately 6,000 new consumer items introduced each year have a life expectancy of even one year (Conner, 1964). Commercial companies, therefore, have a vital stake in the diffusion of new products, and a great number of such researches have undoubtedly been completed. A large proportion of these diffusion research reports, however, are found only in the secret files of the sponsoring companies. Unfortunately, the funding of marketing diffusion studies by private sources, who wish to use the results to gain a competitive advantage, leads to restrictions on scholarly access to the intellectual lessons learned from these studies in the marketing tradition.

Even so, the available research literature in the marketing tradition is quite impressive today. In 1961, there were only a handful of marketing diffusion studies and I did not then consider that a marketing tradition existed (Rogers, 1962). By 1968, however, I could identify sixty-four marketing diffusion publications, 5.9 percent of the total (Rogers with Shoemaker, 1971). By 1981, there were 304 marketing publications, 10 percent of the total, and marketing ranked fourth in its contribution to diffusion research (Table 2-2)! Our tabulation is

complemented by Glazer and Montgomery (1980) who carried out a comprehensive literature search of twenty-five relevant journals in economics, marketing, and general management from 1960 to 1979. They found 407 articles and 81 books, a total of 488 publications, that dealt with the diffusion of innovations.* This literature emphasized the test marketing of new products, identifying markets for new products, strategic planning for diffusion, and studies of how the perceived attributes of an innovation affect its purchase. Clearly, the diffusion approach has caught on in the field of marketing.

"Marketing" has a pejorative ring in some academic circles because the term is narrowly construed as synonymous with manipulating human purchasing behavior for commercial advantage (Rogers and Leonard-Barton, 1978). Marketing scholars do not deny that some marketing efforts are conducted to try to sell products to people who do not really want them. But they argue that most marketing activities, if they are to be very successful, must match consumers' needs and desires with commercial products and services. In fact, marketing researchers argue that they are providing a useful contribution to society by helping to identify consumer needs, and by fulfilling such needs by making commercial products available.

The marketing approach can also be applied to selling noncommercial products, in what is called "social marketing" (Kotler and Zaltman, 1971). Here the objective is to diffuse socially beneficial ideas that do not entail the sale of commercial products. Social marketing was launched about thirty years ago with the rhetorical question "Why can't you sell brotherhood like you sell soap?" (Wiebe, 1952). In the past decade or so, the social marketing approach has been applied to such causes as energy conservation, antismoking, safer driving, family planning, preventing drug abuse, and improving nutrition. Often social marketing campaigns seek to convince people to do something that is unpleasant. For instance, a recent survey showed that nine out of ten smokers in the United States said they would like to quit, yet 57 percent expected that they would still be smoking in five years' time. Likewise, many individuals wish to lose weight, get more exercise, and floss their teeth, but they do not. The mam applications of social marketing, then, are to changing behaviors in directions desired by the individuals involved, but that seem to be impeded by inertia.

* The Glazer and Montgomery (1980) tabulation differs somewhat from ours because of their use of somewhat different criteria for diffusion studies.

An assessment of the past decade of experiences with social marketing by Fox and Kotler (1980) concludes "that most social marketing problems will be more formidable than the typical marketing problems facing commercial marketers." One of the greatest successes for social marketing has been its use by government family-planning programs to diffuse birth control pills and condoms in India, Kenya, Sri Lanka, Thailand, Bangladesh, and Mexico (Rogers, 1973). For example, the condom campaign in India in the early 1970s involved renaming the product as "Nirodh" (from a Sanskritic word meaning "protection"); it had been known as "French letter" or "FL," rather taboo terms. After trying out their Nirodh campaign in a small test market near New Delhi, the social marketers expanded their coverage to one-fifth of India, and then by careful stages to the entire nation. A massive advertising campaign helped launch Nirodh, and the condoms were sold by thousands of teashops and at cigarette stands on every street corner. The government of India subsidized the product so that each condom only cost about two cents. Market research was conducted at every step of the Nirodh campaign to provide feedback for decisions by the campaign planners: the selection of the name Nirodh over various alternatives, which kind of distribution outlet would be most accessible and most acceptable to the intended audience, and what information was needed by Indian men about how to use condoms. Thus, the Nirodh campaign shows how marketing expertise, along with diffusion strategies, were used in this social marketing activity.

The marketing tradition of diffusion research has certain advantages and some attendant disadvantages compared with other research traditions. Because marketing scholars usually conduct diffusion studies with the sponsorship, or at least the collaboration, of the manufacturers of a new product, the researchers are able to conduct field experiments (an especially powerful type of diffusion research design, as we discussed previously). Other than in marketing, diffusion scholars have seldom been in a position to control the intervention strategies through which an innovation is introduced, so it has not been possible to conduct field experiments. In fact, several field experiments on diffusion have been conducted by marketing scholars (for example, Arndt, 1967b, 1971).

But such close siding with the sources of innovations in diffusion research can also bring with it some intellectual and ethical problems. For example, the diffusion problems and needs of marketers are usually given priority over those of the consumers. Sources often wish to know how they can influence the consumers' adoption behavior. In contrast, consumers may wish to know how to insulate themselves from such influence attempts or, more generally, how they can evaluate new products (Rogers and Leonard-Barton, 1978). The source bias in many marketing diffusion studies may lead to highly applied research that, although methodologically sophisticated, deals with trivial diffusion problems. As a result, we may know more about consumer preferences for deodorant scents and the taste of beer than about product safety, or about how best to advance the theory of diffusion.

Geography

Although still one of the smallest of the nine main diffusion research traditions described in this book, the geography tradition has expanded considerably in recent years, and it is unique in its emphasis upon space as a factor affecting the diffusion of innovations.

In 1961, there were only three diffusion publications in geography, all by Dr. Torsten Hagerstrand at the University of Lund in Sweden (Rogers, 1962). By 1968, there were only seven publications in this tradition (0.6 percent of the total), with the four new studies being conducted in the U.S. (Rogers with Shoemaker, 1971). In 1981, there were 130 diffusion publications by geographers, representing about 4 percent of the total.

One's stereotype of the field of geography probably recognizes that maps are one of the geographers' favorite tools. Space is the crucial variable for geographers, and they specialize in investigating how spatial distance affects all other aspects of human existence. Professor Hagerstrand (1952, 1953) pioneered a simulation approach to investigating how spatial distance affected diffusion. First, Hagerstrand constructed a mathematical model of the diffusion process as it should theoretically occur over time and through space. For instance, Hagerstrand's model contained, as one of its elements, the "neighborhood effect," which expressed the tendency for an innovation to be more likely to spread from an adopter to another adopter (in the next unit of time) who was close by, rather than far away. This neighborhood effect was built into Hagerstrand's computer model of diffusion by means of mathematical probabilities (of adoption) that decreased with distance away from the adopter. Hagerstrand then entered a map of the Swedish countryside in his computer, and, begin-

ning with the location of the first adopter of an agricultural innovation, he simulated the diffusion process. He then compared the resulting simulation of diffusion with data on the actual rate of adoption and geographical spread of the farm innovation.

The basic research approach of diffusion simulation is an attempt to mimick the reality of diffusion. If the simulated process does not correspond to the reality data, then the researcher must adjust his theoretical model of diffusion and try again. Hagerstrand remained the dean of the diffusion simulation approach, and for more than a decade few other researchers took up his novel and interesting approach. Not until the mid-1960s did a set of quantitative geographers in the United States begin to pick up on the simulation approach and carry it forward in a series of research studies.

American geographers also began to pursue nonsimulation diffusion research, but always with emphasis on the spatial variable. The results show clearly that space is important in determining the adoption of an innovation. Dr. Lawrence A. Brown of Ohio State University has become a leading figure in the geography diffusion tradition during the 1970s, publishing a number of research papers and an important book (Brown, 1981).

General Sociology

The general sociology tradition of diffusion research is a somewhat residual category, consisting of all other diffusion studies not included in early sociology, rural sociology, and medical sociology. In my previous two books on diffusion, the number of diffusion publications by general sociologists did not justify their consideration as a major diffusion tradition. But since the late 1960s, diffusion studies by general sociologists have proliferated; in 1981, this research tradition included 282 diffusion publications, 9 percent of the total (see Table 2-2). General sociology had climbed to fifth place among the diffusion research traditions.

The rise of general sociology as a research tradition indicates that the diffusion approach is catching on among many sociologists today, not just those concerned with agricultural or medical or health innovations.

Table 2-2 shows six of the minor research traditions on diffusion, in addition to the nine traditions just discussed: general economics, political science, agricultural economics, psychology, statistics, and industrial engineering. These and other minor traditions make up 500

of the 3,085 diffusion publications available in 1981, or about 17 percent. Today all of the behavioral science disciplines are represented by at least a certain degree of interest in the diffusion of innovations.

We can expect further minor diffusion traditions to develop in the future as the diffusion approach continues to spread to other disciplines. But at the same time we expect a more complete merger of the existing traditions, at least at the conceptual and methodological level.

A Typology of Diffusion Research

When showing a large city to a stranger it is often wise to take the visitor first to the top of a skyscraper so that he may scan the entire landscape prior to being immersed in the details of the city. Likewise, in this section we hope to provide the reader with an overall impression of types of diffusion research before we move to a more detailed discussion in later chapters. Our present concern differs from the previous discussion of the history of diffusion research in that we now shall look at *types* of diffusion research, rather than at the *traditions.*

Table 2-3 shows eight different types of diffusion analysis that have been completed and the relative amount of attention paid to each. By far the most popular diffusion research topic has been variables related to individual innovativeness (type 3 in Table 2-3). More than half (58 percent) of all the empirical generalizations reported in available diffusion publications deal with innovativeness. We illustrate each of these eight types of diffusion research with one or two studies, in order to convey the nature of such diffusion investigations.

1. *Earliness of knowing about innovations.* Greenberg (1964) determined what, when, and how people first learned about the news of the assassination of President Kennedy. Data were gathered by telephone interviews with 419 adults in a California city. The respondents were classified as "early knowers" or "late knowers." Most of the early knowers reported that they had heard of Kennedy's death by radio or television, whereas most of the late knowers first learned of the assassination by means of interpersonal communication channels. Most of the individuals who first learned about this news event from a mass medium then told other individuals about the message. And most individuals who first learned about the news through an interpersonal network then turned to a mass media channel for further information and to obtain confirmation of the news event.

2. *Rate of adoption of different innovations in a social system.*

Table 2-3. Types of Diffusion Research.

Type	Main Dependent Variable	Independent Variables	Unit of Analysis	Approximate Percentage of Generalizations of This Type in Available Diffusion Publications *	Chapter in This Book Dealing with This Type of Research	Representative Diffusion Research Study
1	Earliness of knowing about an innovation by members of a social system	Characteristics of members (e.g., cosmopoliteness, communication channel behavior)	Members of a social system (usually individuals)	5	Chapter 5—The Innovation-Decision Process	Greenberg (1964a)
2	Rate of adoption of different innovations in a social system	Attributes of innovations (e.g., complexity, compatibility, etc.) as perceived by members of a system	Innovations	1	Chapter 6—Perceived Attributes of Innovations and Their Rate of Adoption	Fliegel and Kivlin (1966b)
3	Innovativeness of members of a social system (the members may be individuals or organizations)	Characteristics of members (e.g., cosmopoliteness, communication channel behavior, resources available, social status, contact with change agents); system-level variables	Members of a social system (individuals or organizations)	58	Chapter 7—Adopter Categories; and Chapter 10—Innovation in Organizations	Deutschmann and Fals Borda (1962b) Mohr (1969)
4	Opinion leadership in diffusing innovations	Characteristics of members (e.g., cosmopoliteness); system norms and other system variables; communication channel behavior	Members of a social system (usually individuals)	3	Chapter 8—Opinion Leadership and Diffusion Networks	Rogers and van Es (1964)
5	*Who interacts with whom in diffusion networks*	Whether or not a network link exists between two members of a system	Dyadic network links connecting pairs of individuals (or organizations) in a system	Less than 1	Chapter 8—Opinion Leadership and Diffusion Networks	Rogers and Kincaid (1981) Coleman et al (1966)
6	Rate of adoption of innovations in different social systems	System norms; characteristics of the social system (e.g., concentration of opinion leadership); change agent variables (e.g., their strategies of change); types of innovation decisions	Social systems	2	Some attention is given in Chapter 9—The Change Agent; and also in Chapter 10—Innovation in Organizations	Rogers and Kincaid (1981)
7	Communication channel use (e.g., whether mass media or interpersonal)	Innovativeness and other characteristics of members of a social system (e.g., cosmopoliteness); system norms; attributes of the innovations diffusing	Members of a system (or the innovation decision)	7	Chapter 9—The Change Agent; and Chapter 5—The Innovation-Decision Process	Ryan and Gross (1943)
8	Consequences of an innovation	Characteristics of members, the nature of the social system, and the nature and use of the innovation	Members or social systems or innovations	0.2	Chapter 11—Consequences of Innovations	Sharp (1952)
	Others			24		
			Total	100		

* These percentages are based on a content analysis of the 6,811 generalizations identified in the diffusion literature available in 1968, which consisted of 1,084 publications reporting empirical research results. As of 1981 there were 3,085 empirical publications available, but our impression (based on reading these studies) is that the percentages reported in this table have not changed much since 1968 (when the complete content analysis was conducted).

Fliegel and Kivlin (1966b) conducted personal interviews with 229 Pennsylvania dairy farmers. The investigation used farmers' perceptions of fifteen attributes of each of thirty-three dairy innovations to predict the rate of adoption for this sample of Pennsylvania farmers. Innovations perceived as most economically rewarding and least risky were adopted more rapidly. The complexity, observability, and trialability of the innovations were less highly related to the rate of adoption, but innovations that were more compatible with farmers' values were adopted more rapidly.

3. *Innovativeness.* Deutschmann and Fals Borda (1962b) conducted a diffusion survey in a Colombian village to test the cross-cultural validity of correlates of innovativeness derived from prior U.S. diffusion research. The primary hypothesis of the study was that after taking cultural differences into account, the basic pattern of diffusion of new farm ideas would be substantially the same in Saucio (the Colombian village) as in the United States. A striking similarity was found between the results obtained from the Colombia study and those reported for Ohio farmers (by Rogers, 1961): The characteristics of innovators such as greater cosmopoliteness, higher education, and larger-sized farms were remarkably similar in Saucio and in Ohio.

Another variant of the correlates-of-innovativeness study is Mohr's (1969) survey of the directors of county departments of public health in Michigan, Ohio, and Ontario (Canada). An innovativeness score was computed for each of the 120 health departments of study, indicating the degree to which each organization had adopted various new ideas in public health. The most innovative health departments were characterized by more financial resources, a director who was more highly committed to innovation, and larger size.

4. *Opinion leadership.* The success or failure of diffusion programs rests in part on the role of opinion leaders and their relationship with change agents. Rogers and van Es (1964) sought (1) to identify opinion leaders in five Colombian villages; (2) to determine their social characteristics, communication behavior, and cosmopoliteness; and (3) to determine the differences in these correlates of opinion leadership on the basis of systems with different norms. The data were gathered in personal interviews with 160 peasants in 3 modern villages and with 95 peasants in two traditional communities. Rogers and van Es found that opinion leaders, when compared to their followers in *both* modern and traditional systems, were characterized by more formal education, higher levels of literacy, larger farms, greater innovativeness, higher social status, and more mass-media exposure. In the modern villages, however, the opinion leaders were young and innovative, reflecting the norms, whereas in the traditional systems the leaders were older and not very active in adopting new ideas (Rogers with Svenning, 1969). Thus, the leaders tended to reflect the norms of their village.

5. *Who interacts with whom.* Rogers and Kincaid (1981, pp. 303-SOS) conducted personal interviews with the sixty-nine married women in a Korean village in order to determine the role of interpersonal networks in the diffusion of family-planning innovations. Each respondent was asked which other women she talked with about contraceptive methods. Spatial location of each respondent's home was a very important predictor of who talked with whom, even though the village was extremely small (only about two typical city blocks in diameter). But space was by no means a complete explanation of diffusion networks links; in fact some women talked with a peer on the opposite side of the village. Physically lengthy links were especially characteristic of opinion leaders, which suggested that one of the important roles of such leaders was to interconnect the spatially related cliques in the village, and thus to increase the connectedness of the village's communication structure. Social similarity also helped explain who was linked to whom; women of similar social status and age were more likely to interact with each other. A general conclusion from who-to-whom studies is that space and social distance (that is, heterophily/homophily) are the main determinants of who talks to whom in diffusion networks.

We have already mentioned in this chapter the drug diffusion study by Coleman et al (1966). As one part of their investigation, these diffusion scholars asked their respondents to name the other doctors who were their best friends. Coleman et al then determined the main variables that explained who talked to whom in network links. Similarity in age, religion, hometown, and the medical school attended were important factors structuring who talked to whom. But the most important variables determining who-to-whom links in the medical community were such professional affiliations as practicing in the same clinic, hospital, or office partnership. Doctors were more likely to talk about the new drug if they worked together.

6. *Rate of adoption in different social systems.* Rogers and Kincaid (1981, pp. 279-281) sought to explain the rate of adoption of family planning innovations in twenty-four Korean villages. Unlike diffusion research type 2, where the purpose is to explain why some innovations have a faster rate of adoption than others, in this type of

research we study why the same innovation is adopted more rapidly in certain systems than it is in others. The Korean villages with the fastest rates of family-planning adoption were composed of families with higher mass-media exposure to family planning, had leaders with more highly connected networks in their village, and were villages with more change agent contact. The economic resources of the village were less important in explaining rate of adoption.

7. *Communication channel usage.* The Ryan and Gross (1943) investigation of the diffusion of hybrid-seed corn in Iowa found that the typical Iowa farmer first heard of hybrid seed from a commercial salesman but that neighbors were the most influential channel in persuading a farmer to adopt the innovation (although later research has generally shown that salesmen are not the most important channel at the knowledge stage). Ryan and Gross were the first researchers to suggest that an individual passes through different stages (knowledge and persuasion, for example) in adopting a new idea. Different communication channels play different roles at these various stages in the innovation-decision process. Salesmen were more important channels about the innovation for earlier adopters, and neighbors were more important for later adopters. This finding suggests that communication channel behavior is different for the various adopter categories, a proposition that is supported by later diffusion researches.

8. *Consequences of innovation.* The consequences of the use of the steel ax by a tribe of aborigines were studied by Sharp (1952). The Yir Yoront were relatively unaffected by modern civilization, owing to their isolation in the Australian bush, until some missionaries moved in nearby. They distributed steel axes among the Yir Yoront as gifts and as pay for work performed. Before the introduction of the steel ax, the stone ax had served as the Yir Yoront's principal tool and as a symbol of masculinity and respect. Only men could own stone axes, so the women and children, who were the main users of these tools, borrowed them according to a system prescribed by custom. But the missionaries gave axes to anyone. The steel axes caused a major disruption of Yir Yoront culture, and a revolutionary confusion of age and sex roles. Elders, once highly respected, now became dependent upon women and younger men for steel axes. The consequences of the steel ax were unanticipated, far-reaching, and disruptive (as we shall detail in Chapter 11).

The reader has now been provided with a brief glimpse of the diffusion landscape in terms of the eight directions in which it has been growing. In later chapters of this book, we shall probe these eight types of diffusion research in much greater detail. We hope that the typology of diffusion research just discussed, although brief, will provide the reader with an overall research map of the entire field.

Summary

A theme of the present chapter is that although diffusion research began as a series of scientific enclaves, it has emerged in recent years as a single, integrated body of concepts and generalizations, even though the investigations are conducted by researchers in several scientific disciplines. A *research tradition* is a series of investigations on a similar topic in which successive studies are influenced by preceding inquiries. Nine major diffusion traditions are described: anthropology, early sociology, rural sociology, education, medical sociology, communication, marketing, geography, and general sociology.

Eight main types of diffusion research are identified, and dealt with in detail in future chapters:

1. Earliness of knowing about innovations.
2. Rate of adoption of different innovations in a social system.
3. Innovativeness.
4. Opinion leadership.
5. Who interacts with whom in diffusion networks.
6. Rate of adoption in different social systems.
7. Communication channel usage.
8. Consequences of innovation.

Our tour in this chapter of the past forty years of diffusion research provides many examples of Thorsten Veblen's concept of "trained incapacity": by being taught to "see" innovativeness, opinion leadership, and other aspects of the classical model of diffusion, we failed to "see" much else. Acceptance of an intellectual paradigm by scholars in a research field enables them to cope with uncertainty and information overload, through the simplification of reality that the paradigm represents. It also imposes and standardizes a set of assumptions and conceptual biases that, once begun, are difficult to recognize and overcome. That is the challenge for the next generation of diffusion scholars.

A critical statement that appeared in my first book on diffusion (Rogers 1962, p. x) is perhaps still fitting today, twenty years later:

"This book suggests that students of diffusion have been working where the ground was soft.... The challenge for future research is to expand the area of digging and to search for different objectives than those of the past. Perhaps there is a need to dig deeper, in directions that theory suggests."

CHAPTER 3

Contributions and Criticisms of Diffusion Research

Innovation has emerged over the last decade as possibly the most fashionable of social science areas.

George W. Downs and Lawrence B. Mohr (1976), "Conceptual Issues in the Study of Innovations."

Perhaps the most alarming characteristic of the body of empirical study of innovation is the extreme variation among its findings, what we call instability.

George W. Downs and Lawrence B. Mohr (1976), "Conceptual Issues in the Study of Innovations."

THE PURPOSE OF THIS CHAPTER is to review the main criticisms and shortcomings of diffusion research, and to point out directions for future amelioration of current weaknesses of diffusion studies. We discuss such issues as: what are the assumptions and biases of diffusion research, and how has acceptance of the classical diffusion model limited the originality and appropriateness of the work of diffusion researchers? Only during the 1970s did a few observers begin to raise criticisms about diffusion. We feel these criticisms should be taken seriously for they offer directions for future improvement of the diffusion field.

And despite these intellectual criticisms, we should not forget that the field of diffusion research has reached a point in which its contributions are highly regarded, both in providing theoretical under-

standing of human behavior change and at the level of practice and policy.

The Contributions and Status of Diffusion Research Today

The status of diffusion research today is impressive. During the 1960s and 1970s, the results of diffusion research have been incorporated in basic textbooks in social psychology, communication, public relations, advertising, marketing, consumer behavior, rural sociology, and other fields. Both practitioners (like change agents) and theoreticians have come to regard the diffusion of innovations as a useful field of social science knowledge. Many U.S. government agencies have a division devoted to diffusing technological innovations to the public or to local governments; examples are the U.S. Department of Transportation, the National Institutes of Health, the U.S. Department of Agriculture, and the U.S. Department of Education. These same federal agencies also sponsor research on diffusion, as does the National Science Foundation and a number of private foundations. We have previously discussed the applications of diffusion approaches in agricultural development and family planning programs in Latin America, Africa, and Asia. Further, most commercial companies have a marketing department that is responsible for diffusing new products and a market research activity that conducts diffusion investigations in order to aid the company's marketing efforts. Because innovation is occurring throughout modern society, the applications of diffusion theory and research are found in many places.

Diffusion research, thus, has achieved a prominent position today. Such has not always been the case. Some years ago, two members of the diffusion research fraternity, Fliegel and Kivlin (1966b), complained that this field had not yet received its deserved attention from students of social change: "Diffusion of innovation has the status of a bastard child with respect to the parent interests in social and cultural change: Too big to ignore but unlikely to be given full recognition." * The status of diffusion research has improved considerably in the eyes

* Their impression was most directly based upon the writings of La Piere (1965) and Moore (1963, pp. 85-88).

of academic scholars since the Fliegel and Kivlin assessment: for example, said one study, "Innovation has emerged over the last decade as possibly the most fashionable of social science areas" (Downs and Mohr, 1976). A variety of behavioral science disciplines are involved in the study of innovation. Said the same study, "This popularity is not surprising. The investigations by innovation research of the salient behavior of individuals, organizations, and political parties can have significant social consequences. [These studies] imbue even the most obscure piece of research with generalizability that has become rare as social science becomes increasingly specialized" (Downs and Mohr, 1976).

What is the appeal of diffusion research to scholars, to sponsors of such research, and to students, practitioners, and policy-makers who use the results of diffusion research? Why has so much diffusion literature been produced?

1. The diffusion model is a conceptual paradigm with relevance for many disciplines. The multidisciplinary nature of diffusion research cuts across various scientific fields; a diffusion approach provides a common conceptual ground that bridges these divergent disciplines and methodologies. There are few disciplinary limits on who studies innovation. Most social scientists are interested in social change; diffusion research offers a particularly useful means to gain such understandings because innovations are a type of communication message whose effects are relatively easy to isolate. Perhaps there is a parallel to the use of radioactive tracers in studying the process of plant growth. One can understand social change processes more accurately if the spread of a new idea is followed over time as it courses through the structure of a social system. Because of their salience, innovations usually leave deep scratches on individual minds, thus aiding respondents' recall ability. The foreground of scientific interest thus stands out distinctly from background "noise." The process of behavior change is illuminated in a way that is distinctive to the diffusion research approach, especially in terms of the role of concepts like information and uncertainty. The focus of diffusion research on tracing the spread of an innovation through a system in time and/or in space has the unique quality of giving "life" to a behavioral change process. A conceptual and analytical strength is gained by incorporating time as an essential element in the analysis of human behavior change.

Diffusion research offers something of value to each of the social

science disciplines. Economists are centrally interested in growth; technological innovation is one means to foster the rate of economic growth in a society. The degree of diffusion of a technological innovation is often used as an important indicator of socioeconomic development by scholars of development. Students of organization are concerned with processes and patterns of change in and between formal institutions, and in how organizational structure is altered by the introduction of a new technology. Social psychologists try to understand the sources and causes of human behavior change, especially as such individual change is influenced by groups and networks to which the individual belongs. Sociologists and anthropologists share an academic interest in social change, although they usually attack the study of change with different methodological tools. The exchange of information in order to reduce uncertainty is central to communication research. So the diffusion of innovations is of note to each of the social sciences.

2. The apparent pragmatic appeal of diffusion research in solving problems of research utilization is high. The diffusion approach seems to promise a means to provide solutions (1) to individuals and/or organizations who have invested in research on some topic and seek to get it utilized, and/or (2) those who desire to use the research results of others to solve a particular social problem or fulfill a need. This promise has attracted many researchers to the diffusion arena even though fulfillment of this potential has yet to be fully proven in practice. The diffusion approach helps connect research-based innovations and the potential users of such innovations.

3. The diffusion paradigm allows scholars to repackage their empirical findings in the form of higher-level generalizations of a more theoretical nature. Such an orderly procedure in the growth of the diffusion research field has allowed it to progress in the direction of a gradual accumulation of empirical evidence. Were it not for the general directions for research activities provided by the diffusion paradigm, the impressive amount of research attention given to studying diffusion would not amount to much. Without the diffusion model, this huge body of completed research would just be "a mile wide and an inch deep."

4. The research methodology implied by the classical diffusion model is clear-cut and relatively facile. The data are not especially difficult to gather; the methods of data analysis are well laid out. Diffusion scholars have focused especially on characteristics related to individual innovativeness through cross-sectional analysis of survey data. Although the methodological straightforwardness of such diffusion studies encouraged the undertaking of many such investigations, it also may have restricted their theoretic advance.

Criticisms of Diffusion Research

Although diffusion research has made numerous important contributions to our understanding of human behavior change, its potential would have been even greater had it not been characterized by such shortcomings and biases as those discussed in this section. If the 1940s marked the original formulation of the diffusion paradigm, the 1950s were a time of proliferation of diffusion studies in the United States, the 1960s involved the expansion of such research in developing nations, and the 1970s have been the era of introspective criticism for diffusion research. Until the past decade, almost nothing of a critical nature was written about this field; such absence of critical viewpoints may have indeed been the greatest weakness of all of diffusion research.

Every field of scientific research makes certain simplifying assumptions about the complex reality that it studies. Such assumptions are built into the intellectual paradigm that guides the scientific field. Often these assumptions are not recognized, even as they affect such important matters as what is studied and what ignored, and which research methods are favored and which rejected. So when a scientist follows a theoretical paradigm, he or she puts on a set of intellectual blinders that help the researcher to avoid seeing much of reality.' 'The prejudice of [research] training is always a certain 'trained incapacity': the more we know about how to do something, the harder it is to learn to do it differently" (Kaplan, 1964, p. 31). Such "trained incapacity" is, to a certain extent, necessary; without it, a scientist could not cope with the vast uncertainties of the research process in his field. Every research worker, and every field of science, has many blind spots.

The growth and development of a research field is a gradual puzzle-solving process by which important research questions are identified and eventually answered. The progress of a scientific field is helped by realization of its assumptions, biases, and weaknesses. Such

self-realization is greatly assisted by intellectual criticism. That is why, as we stated in our Preface, it is healthy for the diffusion field now to face the criticisms raised during the 1970s.

The Pro-Innovation Bias of Diffusion Research

One of the most serious shortcomings of diffusion research is the pro-innovation bias. This problem was one of the first biases to be recognized (Rogers with Shoemaker, 1971, pp. 78-79), but very little, at least so far, has been done to remedy this problem. What is the pro-innovation bias? Why does it exist in diffusion research? Why isn't something being done about it? And what could be done?

The *pro-innovation bias* is the implication of most diffusion research that an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither re-invented nor rejected.* Seldom is the pro-innovation bias straightforwardly stated in diffusion publications. Rather, the bias is assumed and implied. This lack of recognition of the pro-innovation bias makes it especially troublesome and potentially dangerous in an intellectual sense. The bias leads diffusion researchers to ignore the study of ignorance about innovations, to underemphasize the rejection or discontinuance of innovations, to overlook re-invention, and to fail to study antidiffusion programs designed to prevent the diffusion of "bad" innovations (like marijuana or drugs or cigarettes, for example). The net result of the pro-innovation bias in diffusion research is that we have failed to learn about certain very important aspects of diffusion; what we do know about diffusion is unnecessarily rather limited. But it need not be so.

REASONS FOR THE PRO-INNOVATION BIAS

How did the pro-innovation bias become injected in diffusion research? Part of the reason is historical. Undoubtedly, hybrid corn *was* profitable for each of the Iowa farmers in the Ryan and Gross (1943)

* A more general case of the pro-innovation bias may be what Nelkin (1973) calls the "technological fix," an overdependence on technological innovations to solve complicated social problems. An illustration was the use of methadone to "solve" the problem of heroin addiction in the United States in the 1970s.

study, but most other innovations that have been studied do not have this extremely high degree of relative advantage. Many individuals, for their own good, should *not* adopt them. Perhaps if the field of diffusion research had not begun with highly profitable agricultural innovations in the 1940s and 1950s, the pro-innovation bias would have been avoided, or at least recognized and dealt with properly.

During the 1970s, several critics of diffusion research recognized the pro-innovation bias. For example, Downs and Mohr (1976) stated: "The act of innovating is still heavily laden with positive value. Innovativeness, like efficiency, is a characteristic we want social organisms to possess. Unlike the ideas of progress and growth, which have long since been casualties of a new consciousness, innovation, especially when seen as more than purely technological change, is still associated with improvement."

What causes the pro-innovation bias in diffusion research?

1. Much diffusion research is funded by change agencies; *they* have a pro-innovation bias (understandably so, since they are in the business of promoting innovations) and this viewpoint has often been accepted by many of the diffusion researchers whose work they sponsor, whom they call upon for consultation about their diffusion problems, and whose students they may hire.

2. "Successful" diffusions leave a rate of adoption that can be retrospectively investigated by diffusion researchers, while an unsuccessful diffusion does not leave visible traces that can be very easily studied. For instance, a rejected and/or a discontinued innovation is not so easily identified and investigated by a researcher by interrogating the rejectors and/or discontinuers. For somewhat similar reasons, the variety of forms taken by the re-inventions of an innovation make it more difficult to study, posing methodological problems of classifying just what an "adoption" is. The conventional methodologies used by diffusion researchers lead to a focus on investigating successful diffusion. And thus, a pro-innovation bias results in diffusion research.

One of the important ways in which the pro-innovation bias creeps into many diffusion researches is through the selection of which innovations are studied. This aspect of the pro-innovation bias may be especially dangerous because it is implicit, latent, and largely unintentional. How are innovations of study selected in diffusion research? There are two main ways.

1. Sometimes the sponsor of an investigation comes to a diffusion researcher with a particular innovation (or a class of innovations)

already in mind. For example, the manufacturer of home computers may request a diffusion researcher to study how this product is diffusing, and, on the basis of the ensuing research findings, provide recommendations for speeding up the diffusion process. Or a federal government agency may provide funds to a university-based diffusion researcher for a research project on the diffusion of a technological innovation to local governments; an illustration is a federally promoted innovation like Dial-A-Ride, which is adopted and implemented by local transportation agencies (Rogers et al, 1979b).

2. In many other cases, the diffusion researcher selects the innovations of study (with little influence from the research sponsor) on the basis of which innovations look intellectually interesting to the investigator. If everything else is equal, the researcher is likely to choose for study innovations that are having a relatively rapid rate of adoption. Such innovations are often perceived as particularly noteworthy and dynamic. They are more likely to have policy implications. But the unintended result is that the pro-innovation bias is injected into the diffusion study.

As a general result of the pro-innovation bias, we know much more (1) about the diffusion of rapidly diffusing innovations than about the diffusion of slowly diffusing innovations, (2) about adoption than about rejection, and (3) about continued use than about discontinuance. The pro-innovation bias in diffusion research is understandable from the viewpoint of financial, logistical, methodological, and practical policy considerations. The problem is that the pro-innovation bias is limiting in an intellectual sense; we know too much about innovation successes, and not enough about innovation failures.

In the distant past, say the 1950s, when not so much diffusion research had been completed, perhaps the pro-innovation bias was not such a serious shortcoming. After all, diffusion investigations had to start somewhere. But in the 1980s, with over 3,000 diffusion publications on our hands, we do not need "more of the same." Instead, diffusion scholars need to emphasize originality and creativity in their research designs. We need a different kind of diffusion study from those of the past, one that stresses identification of yet-uninvestigated aspects of diffusion. And one such underinvestigated aspect would be diffusion studies that shed the pro-innovation bias. For balance, in fact, we need a number of diffusion researches with an "anti-innovation bias" in order to correct past tendencies.

STEPS TOWARD OVERCOMING THE PRO-INNOVATION BIAS

How might the pro-innovation bias be overcome?

1. Alternative research approaches to post hoc data gathering about how an innovation has diffused should be explored. We think that diffusion research does not necessarily just have to be conducted *after* an innovation has diffused completely to the members of a system (Figure 3-1). Such a rearward orientation to most diffusion studies helps lead them to a concentration on successful innovations. But it is also possible to investigate the diffusion of an innovation while the diffusion process is still underway (Figure 3-2). In fact, a particularly robust kind of diffusion inquiry would be one in which data were gathered at two or more points during the diffusion process (rather than just after diffusion is completed). The author has conducted such an in-process type of diffusion study. It faces certain problems also (Rogers et al, 1975; Agarwala-Rogers et al, 1977). For instance, the results of our first data gathering (when the innovation was only adopted by a relatively few individuals) were implemented by the change agency into a series of new diffusion strategies that affected the diffusion process which we then studied at a later point in

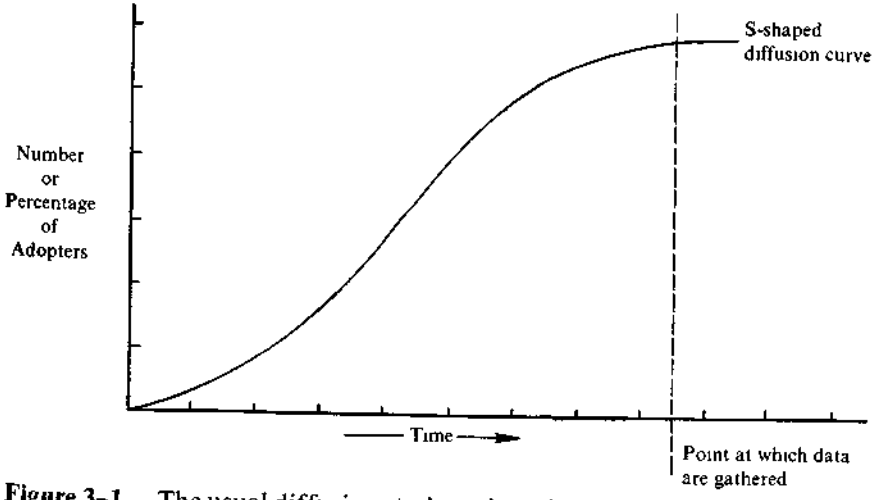

Figure 3–1. The usual diffusion study gathers data from adopters after the innovation has diffused widely by asking respondents to look backward retrospectively in time; because cases of successful diffusion are usually selected for study, a pro-innovation bias is introduced in much diffusion research.

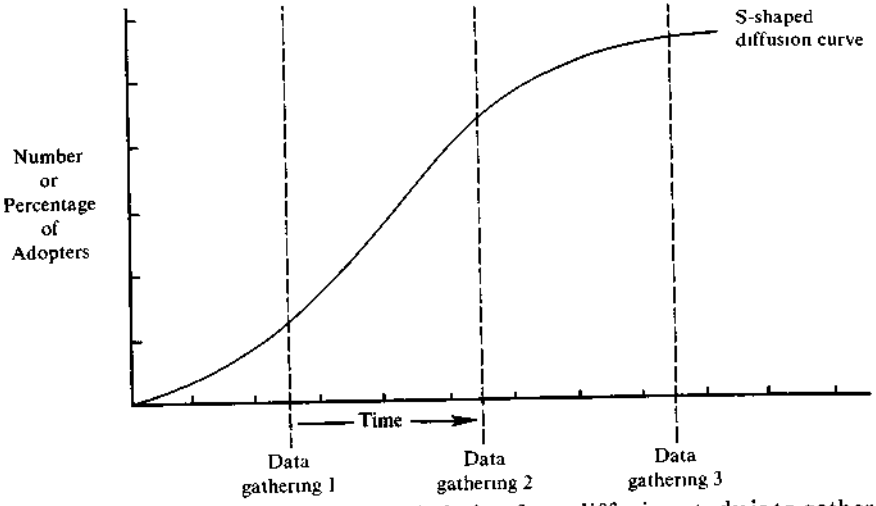

Figure 3-2. An alternative research design for a diffusion study is to gather data from adopters at several points in time during the diffusion process.

time. This feedback effect changed the diffusion process from what it would otherwise have been, and limited the generalizability of the findings to other diffusion situations. The problem is that our object of study, the diffusion process for an innovation, was changing during the time that we were studying it. Nevertheless, such an in-process diffusion research design allows a scholar to investigate less successful as well as more successful cases of innovation diffusion, and therefore partly to avoid the pro-innovation bias.

2. Diffusion researchers should become much more questioning of, and careful about, how they select their innovations of study. Even if a successful innovation is selected for investigation, a diffusion scholar might also investigate an unsuccessful innovation that failed to diffuse widely among members of the same system (Figure 3-3). Such a comparative analysis would help illuminate the seriousness of the pro-innovation bias. In general a much wider range of innovations should be studied in diffusion research.

3. It should be acknowledged that rejection, discontinuance, and re-invention frequently occur during the diffusion of an innovation, and that such behavior may be rational and appropriate from the individual's point of view, if only the diffusion scholar could adequately understand the individual's perceptions of the innovation and of his or her own situation, problems, and needs (Figure 3-4). For instance, one motivation for re-invention is that adopters wish to be "doers"

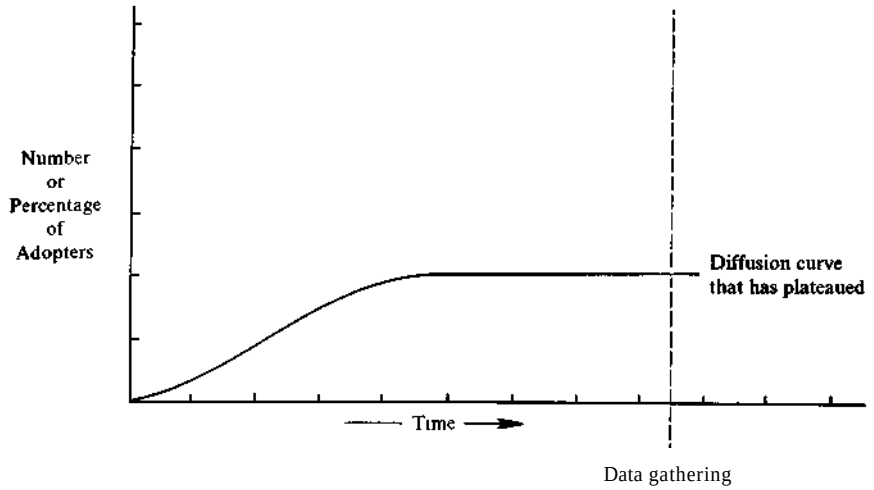

Figure 3-3. Diffusion research can also help shed the pro-innovation bias by investigating unsuccessful diffusion, where the rate of adoption has plateaued; an example might be the use of seat belts in the United States, which has plateaued at about 20-25 percent.

rather than just "doees," relative to a new idea. They often feel that they know of relevant information about their local situation that the external change agent may not know or understand. Re-invention is an important way in which the innovation is changed to fit the adopt-

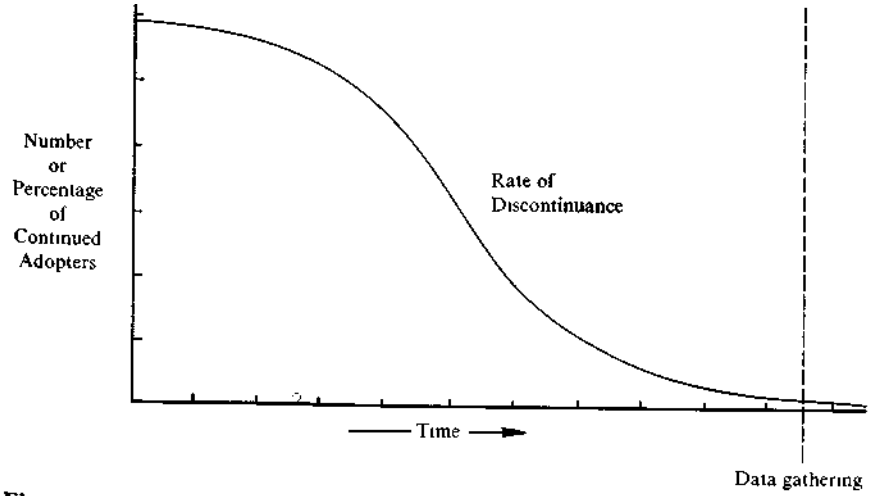

Figure 3-4. Diffusion researchers can also investigate how a practice is discontinued; an example might be the discontinuance of cigarette smoking or the discontinuance of a technological innovation that has been found to have undesirable side effects.

ing unit's situation. As we show in Chapter 5, for the first thirty-five years or so of diffusion research, we simply did not recognize that reinvention existed. An innovation was regarded by diffusion scholars as an invariant during its diffusion process. Now we realize, belatedly, that an innovation may be perceived somewhat differently by each adopter and modified to suit the individual's particular situation. Thus, diffusion scholars no longer assume that an innovation is "perfect" for all potential adopters in solving their problems and meeting their needs.

4. Researchers should investigate the broader context in which an innovation diffuses, such as how the initial decision is made that the innovation should be diffused to members of a system, how public policies affect the rate of diffusion, how the innovation of study is related to other innovations and to the existing practice(s) that it replaces, and how it was decided to conduct the R&D that led to the innovation in the first place (Figure 3-5). This wider scope to diffusion studies helps illuminate the broader system in which the diffusion process occurs. As explained in Chapter 4, there is much more to diffusion than just variables narrowly related to an innovation's rate of adoption.

5. We should increase our understanding of the motivations for adopting an innovation. Strangely, such "why" questions about adopting an innovation have only seldom been probed by diffusion researchers; undoubtedly, motivations for adoption are a difficult issue

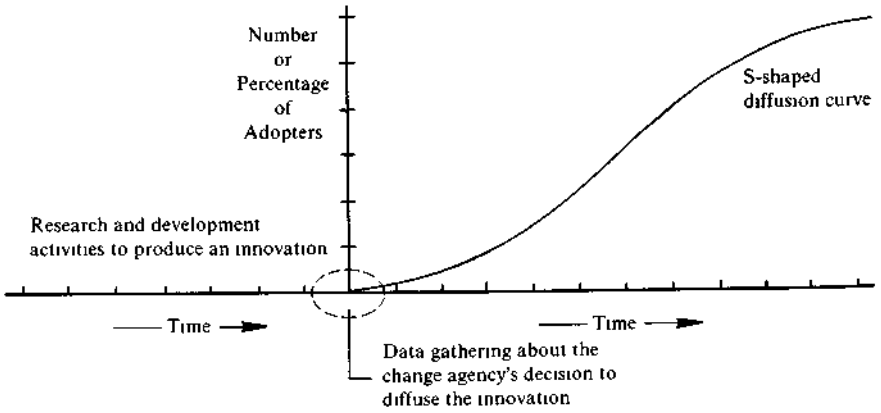

Figure 3-5. Another means of avoiding the pro-innovation bias might be to investigate the broader context of diffusion, such as the decision by the change agency to diffuse the innovation; one might also study how the decision was made to begin R&D work to produce the innovation.

to investigate. Some adopters may not be able to tell a researcher why they decided to use a new idea. Other adopters may be unwilling to do so. Seldom are simple, direct questions in a survey interview adequate to uncover an adopter's reasons for using an innovation. But we should not give up on trying to find out the "why" of adoption just because valuable data about adoption motivations are difficult to obtain by the usual methods of diffusion research data gathering.

It is often assumed that an economic motivation is the main thrust for adopting an innovation, especially if the new idea is expensive. Economic factors are undoubtedly very important for certain types of innovations and their adopters, such as the use of agricultural innovations by U.S. farmers. But the prestige secured from adopting an innovation before most of one's peers may also be important. For instance, Becker (1970a, 1970b) found that prestige motives were very important for county health departments in deciding to launch new health programs. A desire to gain social prestige was also found to be important by Mohr (1969) in his investigation of the adoption of technological innovations by health organizations. Mohr explained that "a great deal of innovation in [health] organizations, especially large or successful ones, is 'slack' innovation. After solution of immediate problems, the quest for prestige rather than the quest for organizational effectiveness or corporate profit motivates the adoption of most new programs and technologies." Perhaps prestige motivations are less important and profit considerations are paramount in private organizations, unlike the public organizations studied by Becker and Mohr. But we simply do not know because so few diffusion researchers have tried to assess motivations for adoption.

I believe that if diffusion scholars could more adequately see an innovation through the eyes of their respondents, including a better understanding of why the innovation was adopted, the diffusion researchers would be in a better position to shed their pro-innovation bias of the past. A pro-innovation tilt is dangerous in that it may cloud the real variance in adopters' perceptions of an innovation. An astute observer of diffusion research, Dr. J. D. Eveland (1979), stated: "There is nothing inherently wrong with … a pro-innovation value system. Many innovations currently on the market are good ideas in terms of almost any value system, and encouraging their spread can be viewed as virtually a public duty." But even in the case of an overwhelmingly advantageous innovation, a researcher should not forget that the various individuals in the potential audience for an innovation may perceive it in light of many possible sets of values. If the

researcher is to understand their behavior in adopting or rejecting the innovation, the researcher must be capable of taking their various points of view (Eveland, 1979). Simply to regard adoption of the innovation as rational and wise and to classify rejection as irrational and stupid is to fail to understand that individual innovation decisions are idiosyncratic and particularistic. They are based on the *individual's* perceptions of the innovation. Whether considered as right or wrong by a scientific expert who seeks to evaluate an innovation objectively, an adoption/rejection decision is always right in the eyes of the individual who is making the innovation-decision (at least at the time the decision is made).

In the past, we diffusion researchers have placed an overreliance upon models of diffusion that are too rationalistic. The unfortunate consequence is that we have often assumed that all adopters perceive an innovation in a positive light, as we ourselves may perceive it. Now we need to question this assumption of the innovation's advantage for adopters.

Certainly the first and most important step in shedding a pro-innovation bias in diffusion research is to recognize that it may exist.

Bottle Feeding Babies in the Third World and the Evil Eye

While most diffusion programs that occur in most countries have beneficial consequences for most people who adopt the innovations that are promoted (thus at least partially justifying the pro-innovation bias of past diffusion research), there are many cases in which an innovation that is generally beneficial can be disastrous for *certain* adopters. And in a few cases, an innovation that diffuses widely has disastrous consequences for *most* adopters.

One illustration is the diffusion of bottle feeding among poor mothers in the Third World countries of Latin America, Africa, and Asia. Bottle feeding with prepared infant formulas (as a replacement for breast feeding of babies) has been promoted by several multinational corporations (headquartered mainly in the United States, Switzerland, and England). These huge multinationals use massive mass-media campaigns to diffuse the innovation of bottle feeding to poor parents in developing nations. The ads, carried mainly on radio and in newspapers, portray bottle feeding as essential to raising healthy babies; the infants depicted in the print ads are fat and happy, and their mothers are shown as young and beautiful. One company's ads stated: "Give your baby love and Lactogen." The advertising uses status and modernity appeals; bottle feeding is depicted as a practice used by higher-income well-educated families who live in attractive urban homes. By

implication, if a peasant family adopts bottle feeding, they are urged to think that they will become more like the modern, higher-socioeconomic-status parents shown in the advertising. In many developing nations of Latin America, Africa, and Asia, bottle feeding is one of the most widely advertised products in the mass media, surpassed only by alcoholic products and cigarettes. The result is that during the 1960s and 1970s, a major increase occurred in the rate of adoption of bottle feeding by mothers in Third World nations. Bottle feeding rose from 5 percent of all babies born, to 10 percent, 25 percent, and to over 50 percent in many nations.

So what's wrong with bottle feeding? Nothing at all, under ideal conditions where a family has sufficient income to purchase the expensive powdered milk (which often costs up to one-third of a family's total income), and where sanitary conditions are available to prepare the baby formula. But most Third World families cannot afford to buy sufficient amounts of powdered milk products, so they water down their baby's formula. And they lack pure water or the resources to boil polluted water for preparing the formula. Often these poor families are unable to clean the bottles and other bottle-feeding equipment properly. Bacteria multiply in the emptied milk bottles, which are then refilled without being sterilized. Instead of contributing to infant health (as bottle feeding can do under ideal conditions), the germ-ridden baby bottles become a life-threatening, even a lethal, problem under the reality of village and urban slum conditions.

Consequently, bottle feeding contributes directly to widespread infant diarrhea in Third World countries. Diarrhea is the leading cause of infant deaths in many nations, often killing up to 50 percent of all babies. It is common to see many babies in developing nations with distended stomachs, sticklike arms and legs, and glazed eyes, the likely symptoms of "bottle-feeding disease." Even if such babies are hospitalized for a month or two and fed intravenously to return them to good health, they are often bottle-fed again after their hospital discharge and succumb to diarrheal malnutrition.

During the late 1970s, a number of religious, student, and other protest groups began to raise public consciousness about the problem of bottle-feeding diffusion. Lawsuits were initiated against the multinational corporations, seeking to force them to halt their advertising campaigns aimed at poor parents in Third World nations. The World Health Organization (WHO) took a position against bottle feeding, and began to assist national ministries of public health in promoting breast feeding as a healthier practice than bottle feeding. Some Third World nations banned all public advertising of bottle-feeding products by the multinational corporations. Other nations forced these companies to halt their promotion of bottle-feeding products to new mothers in the delivery wards of hospitals by "milk nurses" (employees of the milk companies that wear nurses' uniforms).

But the problem of infant diarrhea deaths due to bottle feeding is far

from solved today. A basic reason is because many poor parents in Third World nations attribute the cause of baby diarrhea to the "evil eye" (called "ojo" in Spanish-speaking nations, for example). Evil eye is thought to be caused by a potentially lethal glance from some envious individual at one's healthy infant. The result of evil eye is believed to be diarrhea and eventually death. In order to prevent evil eye, many mothers tie a red thread around a baby's wrist or neck, or a bracelet of black stones, a crocodile's tooth, or a tiger tooth. In Islamic nations, the amulet may contain a phrase from the Koran written on a scrap of paper by a religious leader. And of course any means of avoiding public envy is thought to prevent evil eye and diarrhea; particularly handsome babies should be isolated by keeping them in the home and away from public exposure. The thinking goes that if a fat, healthy baby cannot be seen in public, it will not be envied and thereby subjected to the curse of the evil eye. Under these conditions, the last thing that a stranger should do in a Third World village is to compliment parents on what a beautiful baby they have.

Government public health campaigns to promote breast feeding as a healthier practice than bottle feeding are unlikely to be very successful in combating infant deaths due to diarrhea, as long as such diarrhea is perceived by most Third World parents as caused by the evil eye. Labeling such parents as ignorant and superstitious for believing in the evil eye does not solve the problem of infant diarrhea death. Why not blame the multinational companies that promote bottle feeding?

The role of diffusion research in the infant diarrhea problem has changed over recent decades. In the 1950s and 1960s, the multinational corporations based their advertising campaigns for bottle feeding, in part, upon the results of diffusion research. Since the late 1970s, when public alarm about the bottle-feeding syndrome began to rise, diffusion researchers initiated investigations of how to persuade parents to discontinue bottle feeding and to return to breast feeding. These diffusion scholars, along with cultural anthropologists, played an important role in identifying popular beliefs by Third World parents in the evil eye, as one of the perceptual resistances to public recognition of bottle feeding as the cause of diarrhea-related infant deaths. Some diffusion scholars have recently assisted government health campaigns to promote breast feeding; such campaigns are now underway in several Third World nations.

Bottle-feeding diffusion in developing nations illustrates, in an extreme case, the pro-innovation bias of past diffusion research, and how we have gradually begun to overcome this bias in recent years. This illustration also helps us see that blaming individual parents for the bottle-feeding cause of infant diarrhea does not go far toward solving the problem. It is necessary to recognize that the multinational milk companies play an important role in creating the problem. This recognition of system-blame for the problem may be a first step toward its amelioriation. But it has not proven easy to convince

the corporations to halt their dangerous sale of bottle-feeding products to poor parents.

The Individual-Blame Bias in Diffusion Research

Not only is there a pro-innovation bias in much past diffusion research, there has also been a source-bias, a tendency for diffusion research to side with the change agencies that promote innovations rather than with the audience of potential adopters. This source-bias is perhaps even suggested by the words that we use to describe this field of research: "diffusion" research might have been called something like "problem solving," "innovation seeking," or the "evaluation of innovations" had the audience originally been a stronger influence on this research. One cannot help but wonder how the diffusion research approach might have been different if the Ryan and Gross (1943) hybrid corn study had been sponsored by the Iowa Farm Bureau Federation (a farmers' organization) rather than by an agricultural research center like the Iowa Agricultural Experiment Station. And what if the Columbia University drug study had been sponsored by the American Medical Association, rather than by the Pfizer Drug Company? The source-sponsorship of early diffusion studies may have given these investigations not only a pro-innovation bias but may have also structured the nature of diffusion research in other ways.

INDIVIDUAL-BLAME VERSUS SYSTEM-BLAME

As a result of who sponsors diffusion research, along with other pro-source factors, one can detect a certain degree of individual-blame, rather than system-blame, in much diffusion research. *Individual-blame* is the tendency to hold an individual responsible for his or her problems, rather than the system of which the individual is a part (Caplan and Nelson, 1973). In other words, an individual-blame orientation implies that "if the shoe doesn't fit, there's something wrong with your foot." An opposite point of view would blame the system, not the individual; it might imply that the shoe manufacturer or the marketing system could be at fault for a shoe that does not fit.

Of course it is likely that some of the factors underlying a par-

ticular social problem may indeed be individual in nature, and that any effective solution to the problem may have to deal with changing these individual factors. But in many cases the causes of the social problem lie in the system of which the individual is a part. Ameliorative social policies that are limited to individual interventions will not be very effective in solving system-level problems. How a social problem is defined is an important determinant of how we go about solving it, and therefore of the effectiveness of the attempted solution. A frequent error is to overstress individual-blame in defining a social problem, and to underestimate system-blame. We define *system-blame* as the tendency to hold a system responsible for the problems of individual members of the system.

Consider the following cases in which a social problem was defined initially in terms of individual-blame.

1. Posters produced by a pharmaceutical manufacturer were captioned: "LEAD PAINT CAN KILL!" The posters place the blame on parents for allowing their children to eat paint. In one city, with the highest reported rates of lead-paint poisoning of children in the United States, this problem was solved by legally prohibiting landlords from using lead paint on the inside of residences (Ryan, 1971). But the posters blame the parent, not the paint manufacturers or the landlords. This tendency toward stressing individual-blame rather than system-blame is very common in many health and safety campaigns.

2. Motor vehicle accidents are the leading cause of death for individuals in the United States under thirty-five years of age. Until the mid-1960s, highway safety problems were defined in terms of speeding, reckless driving, and drinking. Massive public communication campaigns were aimed at the individual driver, urging him or her: "Don't Drink and Drive"; "Buckle Up for Safety"; and "Slow Down and Live." Unfortunately, the highway accident rate continued to climb. Ralph Nader's (1965) book, *Unsafe at Any Speed,* helped to redefine the problem from mainly one of persuading "the nut behind the wheel" to drive slower, more carefully, and to drink less alcohol, to a system-blame problem of unsafely designed automobiles and highways (Whiteside, 1972). Once the problem was defined as one of system-blame as well as individual-blame, federal legislative mandates for safer cars and highways followed, and since 1966 the traffic fatality rate has decreased (Walker, 1976, pp. 26-32; 1977). For instance, the 1966 safety laws required more padding on auto dashboards and stronger car bumpers, as well as impact absorbers placed in front of viaduct columns on highways. But the post-1965 redefinition of the traffic safety problem did not deny that individual drivers' behavior, if it could be effectively changed, could also contribute to safer driving. When the fifty-five mile-per-hour speed limit was instituted in late 1973 (as an energy-saving policy), the number of highway deaths promptly dropped about 16 percent below the long-range downward trend.

3. A large training program in Chicago sought to improve the employability of black inner-city men. The training course stressed the importance of punctuality in getting and holding a job but was not able to achieve many results with such an individual-blame approach. Caplan and Nelson (1974), social psychologists at the University of Michigan, were called upon to assess the punctuality problem. They found that only one-fourth of the trainees had alarm clocks or wrist watches, so most had to rely on someone else to wake them up. Further, the retrained workers had to depend upon unreliable public transportation and to cope with traffic congestion in traveling from their inner-city homes to suburban work places. On the basis of their analysis, Caplan and Nelson (1974) recommended that the training program provide alarm clocks to the trainees. Their suggestion was rejected as inappropriate and unrealistic. The government reemployment program could spend thousands for training, but would not spend a few dollars for alarm clocks.

4. When the energy crisis began in 1973, the American public was told that the solution lay in energy conservation, encouraged by government programs and emphasized by much higher gas prices. A U.S. president told his *citizens* that the problem was "the moral equivalent of war," and that they should conserve energy for patriotic reasons. Their wasteful use of energy had to change, they were told. Only a few observers took a system-blame perspective, in which the behavior of oil companies, public utilities, OPEC, and the U.S. government was questioned.

5. During the 1960s and 1970s the government leaders of many developing nations launched national family-planning programs in order to reduce the rate of population growth. Government officials urged their citizens to have fewer children, usually only two or three. But most parents, especially the rural and urban poor, wanted four or five children, including at least two sons, to provide them with cheap family labor on their farms or in their businesses and with care in their

old age. Instead of seeking a system-blame solution, by creating public programs like agricultural mechanization and a social security system to substitute for large families, government officials criticized parents for not adopting contraceptives and for having "too many" children. Such an individual-blame strategy for solving the overpopulation problem has not been very successful in most developing nations, except in certain countries where rapid socioeconomic development has changed the system-level reasons for having large families (Rogers, 1973).

In each of these five illustrations, a social problem was initially defined in terms of individual-blame. The resulting diffusion program to change human behavior was not very successful until, in some cases, system-blame factors were also recognized. These five cases suggest that we frequently make the mistake of defining social problems solely in terms of individual-blame.

INDIVIDUAL-BLAME AND THE DIFFUSION OF INNOVATIONS

"The variables used in diffusion models [to predict innovativeness], then, are conceptualized so as to indicate the success or failure of the individual *within the system* rather than as indications of success or failure *of the system"* (Havens, 1975, p. 107, emphasis in original). Examples of such individual-blame variables that have been correlated with individual innovativeness in past diffusion investigations include formal education, size of operation, income, cosmopoliteness, and mass media exposure. In addition, these past studies of individual innovativeness have included some predictor variables that might be considered system-blame factors, like change agent contact with clients and the degree to which a change agency provides financial assistance (such as in the form of credit to purchase an innovation). But seldom is it implied in diffusion research publications that the source or the channel may be at fault for not providing more adequate information, for promoting inappropriate innovations, or for failing to contact less-educated members of the audience who may especially need the change agent's help.

Late adopters and laggards are often most likely to be individually blamed for not adopting an innovation and/or for being much later in adopting than the other members of their system. Change agents feel that such later adopters are not dutifully following the experts' recommendations to use an innovation. They attribute such an improper response to the explanation that these individuals are traditionally resistant to change, and/or "irrational." In some cases, a more careful analysis showed that the innovation was not as appropriate for later adopters, perhaps because of their smaller-sized operations and more limited resources. Indeed they may have been extremely rational in *not* adopting (if *rationality* is defined as use of the most effective means to reach a given goal). In this case, an approach with more emphasis on system-blame might question whether the R&D source of innovations was properly tuned to the actual needs and problems of the later adopters in the system, and whether the change agency, in recommending the innovation, was fully informed about the actual life situation of the later adopters.

In fact, a stereotype of later adopters by change agents and others as traditional, uneducated, and/or resistant to change may become a self-fulfilling prophecy. Change agents do not contact the later adopters in their system because they feel, on the basis of their stereotypic image, that such contact will not lead to adoption. The eventual result, obviously, is that without the information inputs and other assistance from the change agents, the later adopters are even less likely to adopt. Thus, the individual-blame image of the later adopters fulfills itself. Person-blame interpretations are often in everybody's interest except those who are subjected to individual-blame.

REASONS FOR SYSTEM-BLAME

It may be understandable (although regrettable) that change agents fall into the mental trap of individual-blame thinking about why their clients do not adopt an innovation. But why and how does diffusion research also reflect such an individual-blame orientation?

1. As we have implied previously, some diffusion researchers accept a definition of the problem that they are to study from the sponsors of their research. And so if the research sponsor is a change agency with an individual-blame bias, the diffusion scholar often picks up an individual-blame orientation. The ensuing research may then contribute, in turn, toward social policies of an individual-blame nature. "Such research frequently plays an integral role in a chain of events that results in *blaming people in difficult situations for their*

own predicament" (Caplan and Nelson, 1973, emphasis in original). The series of events is thus:

1. Experts and/or change agents perceive a social problem in individual-blame terms. → 2. Diffusion researchers accept this individual-blame definition, and conduct research accordingly. → 3. Social policies with an individual-blame orientation are formulated and implemented on the basis of this research, which do not effectively solve the social problem.

The essential error on the part of some diffusion researchers in the past is that they may have inadvertently equated the *cause* of an event or a condition, which is a matter to be scientifically and empirically ascertained in a nonevaluative fashion, with the *blame* for an event or a condition, which may be a matter of opinion, based upon certain values and beliefs (Caplan and Nelson, 1973). Cause and blame are thus two different things. But the individual-blame bias in past diffusion research sometimes occurred, it seems, when the researchers uncritically accepted others' definitions of blame as a scientific cause. The investigators should have attributed cause among their variables of study only on the basis of empirical evidence, not on the basis of others' beliefs and judgments.

2. Another possible reason for the individual-blame bias in some diffusion research is that the researcher may feel that he or she is largely helpless to change system-blame factors, but that individual-blame variables may be more amenable to change. System-level variables, especially if they involve changing the social structure of a system, may indeed be difficult to alter. But a first step toward system change might be for social scientists to define (or redefine) a social problem more accurately. We shall have more to say about structural change in a later section on diffusion research in developing countries, where social structure is often a powerful barrier to the diffusion of innovations.

3. Individuals are often more accessible to diffusion researchers as objects for study than are systems, and the research tools of most diffusion investigators lead them to focus on individuals as units of analysis. The diffusion paradigm headed diffusion scholars in the direction of conducting surveys of individual potential adopters; for example, Ryan and Gross (1943) studied individual Iowa farmers. Data gathering from the change agencies diffusing the innovations

and/or the R&D organizations that produced the innovations was not part of the prototypical diffusion study. Officials in such systems may be at least equally to "blame" for certain diffusion problems, as are the potential adopters (who are the usual objects of diffusion study). But it is not very easy for diffusion scholars to study these officials. The pay-off, however, from such research on system-level variables (as we argue in Chapter 4) might in some cases be greater than the pay-off from just another diffusion survey of adopters.

Caplan and Nelson (1973) raise the rhetorical question: "Why do we constantly study the poor rather than the nonpoor in order to understand the origins of poverty?" One answer is that most social scientists who conduct diffusion research are specialists in conducting surveys of potential adopters. This particular research skill helps channel them into an individual-blame definition of diffusion problems, and away from a system-blame viewpoint. Here we see an example of Kaplan's (1964) Law of the Hammer: "It comes as no particular surprise to discover that a scientist formulates problems in a way which requires for their solution just those techniques in which he himself is especially skilled" (Kaplan, 1964, p. 31). It may be noteworthy that the anthropological diffusion research tradition, which does not conduct surveys, has probably been least accepting of an individual-blame point of view, and most likely to point to system-blame aspects of diffusion problems.

Not only is diffusion research especially oriented toward investigating individuals as units of analysis, so is almost all communication research, which has generally followed a mechanistic and atomistic research approach in concentrating on the study of the effects of communication (Rogers and Kincaid, 1981, pp. 32-42). The statistical tools, research methods, and theoretical paradigms all headed communication researchers toward the study of individual-level effects. In the particular case of diffusion research, the effects variables consist of innovativeness or of individual knowledge of innovations. In recent years, network analysis and other research approaches have become recognized and available—methodologies appropriate for investigating more holistic aspects of diffusion that allow us to use dyads, cliques, or systems as units of analysis, rather than just individuals.

The overwhelming focus on the individual as the unit of analysis in diffusion research, while largely ignoring the importance of network relationships, is often due to the assumption that if the individual is the unit of *response,* he must consequently be the unit of *analysis* (Coleman, 1958). The use of survey methods in diffusion research

tended to "destructure" human behavior: "Using random sampling of individuals, the survey is a sociological meat-grinder, tearing the individual from his social context and guaranteeing that nobody in the study interacts with anyone else in it. It is a little like a biologist putting his experimental animals through a hamburger machine and looking at every hundredth cell through a microscope; anatomy and physiology get lost; structure and function disappear and one is left with cell biology" (Barton, 1968).

Even when the individual is the unit of response, network relationships (even though they can't "speak") can be the unit of analysis via some type of network analysis. Sampling and data-analysis procedures for network analysis are being worked out (Rogers and Kincaid, 1981). Until diffusion scholars begin to think in network terms, there will not be much analysis of system-level variables in diffusion research.

Communication network analysis is defined as a method of research for identifying the communication structure in a system, in which relational data about communication flows are analyzed by using some type of interpersonal relationships as the units of analysis (Rogers and Kincaid, 1981). Network analysis is a tool that promises to capitalize on the unique ability of diffusion inquiry to reconstruct specific message flows in a system. The innovation's diffusion brings life to the otherwise static nature of the communication structure variables; network analysis permits understanding of this structure as it channels the process of diffusion.

Relational data about diffusion networks, once obtained, were used to provide deeper insight into the role of opinion leaders in the two-step flow of communication, a conceptualization that was originated prior to most diffusion research by Lazarsfeld et al (1944). The two-step flow hypothesis turned out mainly to be an oversimplification (as the flow of communication messages about an innovation may have any number of steps) later research showed, but the concept of opinion leadership has much theoretical and practical utility (Chapter 8).

As explained previously, the influential Ryan and Gross (1943) study did not obtain data about diffusion networks. The refocusing of diffusion researches had to wait until later investigations, especially the drug study among medical doctors by Coleman and other (1966). Then it became a common procedure for diffusion scholars to ask their respondents sociometric questions of the general form: "From

whom in this system did you obtain information that led you to adopt this innovation?" The sociometric dyad represented by each answer to this question could consequently be identified (including data on the characteristics of the seeker and the sought), which then became the basic unit of analysis. Now the network link, rather than the individual, became the unit of analysis.

The first, and very partial, attempts toward network analysis of the diffusion process simply identified opinion leaders in a system and determined their characteristics. This approach was only a slight extension of the usual monadic analysis toward network analysis.

Next, diffusion scholars began to plot sequential-over-time sociograms of the diffusion of an innovation among the members of a system. And tentative steps were taken toward using network links as the units of analysis. This advance allowed the data analysis of a "who-to-whom" communication network, and facilitated inquiry into the identification (1) of cliques within a total system and how such structural subgroupings affected the diffusion of an innovation, and (2) of specialized communication roles such as liaisons,* bridges, and isolates, thus allowing diffusion research to proceed well beyond the relatively simpler issue of studying just the characteristics of opinion leaders. Further detail on network analysis of diffusion behavior is provided in Chapter 8.

OVERCOMING THE INDIVIDUAL-BLAME BIAS

We have just been discussing one means of overcoming the past tendency of survey research designs to head diffusion scholars toward using individuals as their units of analysis, and thus to accept mainly an individual-blame bias. How else can the person-blame bias be overcome?

1. Researchers must attempt to keep an open mind about the causes of a social problem, at least until exploratory data are gathered, and by guarding against accepting change agencies' definitions of diffusion problems, which tend to be in terms of individual-blame.

* A *liaison* is defined as an individual who links two or more cliques in a system, but **who** is not a member of any clique.

2. All the participants should be involved, including potential adopters, in the definition of the diffusion problem, rather than just those persons who are seeking amelioration of a problem.
3. Social and communication structural variables should be considered, as well as intraindividual variables, in diffusion research. Past diffusion studies largely consisted of audience research, while seriously neglecting source research. The broader issues of who owns and controls (1) the R&D system that produces innovations, and (2) the communication system that diffuses them, and to whose benefit, also need attention in future diffusion investigations.

As in the case of the pro-innovation bias in diffusion research, perhaps one of the first and most important ways to guard against the individual-blame bias is to be aware that it exists. To what extent does diffusion research have an individual-blame bias? It is difficult to assess the degree of individual-blame in past researches accurately, but, on careful reading, there seems to be a certain flavor of individual-blame in many diffusion publications. An individual-blame orientation is not, in and of itself, always inappropriate. Perhaps individual-level variables *are* the most appropriate to investigate in a particular diffusion study. By no means do we advocate the complete discarding of all individual-level, psychological variables in diffusion research. But in almost all cases such a psychological approach, centering on individual-level variables, is not a complete explanation of the diffusion behavior being investigated.

Diffusion scholars should keep a much more open mind toward system-blame explanations of diffusion behavior than they have in the past. And the availability of handy research designs like one-shot audience surveys should not unduly influence diffusion scholars into overemphasizing individual-level explanations of diffusion behavior.

The Recall Problem in Diffusion Research

Time is one of the main methodological enemies in studying a process like diffusion. By definition, an innovation diffuses through time. It might seem a simple enough matter to obtain data from respondents about the time at which they decided to adopt an innovation, but it is not.

PROBLEMS IN MEASURING TIME OF ADOPTION

Diffusion is set off from most other fields of social science research by the fact that the time variable is not ignored. Time is one of the four essential elements of diffusion (Chapter 1), even though it is not often explicitly taken into account in other kinds of behavior research. Diffusion is a process that occurs over time, so there is no way to avoid including time when one studies diffusion. Although there are blessings that accrue from inclusion of the time variable in diffusion studies (for example, the tracerlike qualities of innovations), there are also some methodological curses.

One weakness of diffusion research is its dependence upon *recall data* from respondents as to their date of adoption of a new idea. Essentially, the respondent is asked to look back over his or her shoulder in time and reconstruct his or her past history of innovation experiences. This hindsight ability is clearly not completely accurate (Menzel, 1957; Cougheriour, 1965) for the typical respondent. It probably varies on the basis of the innovation's salience, the length of time over which the recall is requested, and on the basis of individual differences in education, memory, and the like.

Most social science research methods are better suited to obtaining snapshots of behavior, rather than moving pictures, which would be more appropriate for determining the time-order of variables. Diffusion research designs consist mainly of correlational analyses of cross-sectional data gathered in one-shot surveys of respondents (who are usually the adopters and/or potential adopters of an innovation), thus exactly following the method pioneered by Ryan and Gross (1943) in the hybrid corn study. Diffusion studies should be particularly able to rely on "moving pictures" of behavior, rather than "snapshots," because of their unique capacity to trace the sequential flow of an innovation as it spreads through a social system. Diffusion researchers have mainly relied, however, upon a one-shot survey of their respondents, a methodology that amounts to making the diffusion process almost "timeless," by its stop-action effect of freezing the action in a continuous process over time. Survey research on the diffusion process is a convenient methodology for the researcher, but it is intellectually destructive of the "process" aspect of the diffusion of innovations. If data about a diffusion process are only gathered at one point in time, the investigator can only measure time through respondents' recall, and that is a rather weak reed on which to base the measurement of such an important variable as time.

There are more appropriate research designs for gathering data about the time dimension in the diffusion process: (1) field experiments, (2) longitudinal panel studies, (3) use of archival records, and (4) case studies of the innovation process with data from multiple respondents (each of whom provides a validity check on the others' data). (We shall describe these case study approaches to the innovation process in organizations in Chapter 10.) These methodologies provide moving pictures, rather than still photos, of the diffusion process, and thus reflect the time dimension more accurately. Unfortunately, these alternatives to the one-shot survey have not been widely used in past diffusion research. The last time that a tabulation was made of the data-gathering designs used in diffusion research (in 1968 when there were 1,084 empirical diffusion publications), about 88 percent of all diffusion researches were one-time surveys. About 6 percent were longitudinal panel studies with data gathered at two or more points in time, and 6 percent were field experiments. Our impression is that these proportions would be about the same today. The research design predominantly used in diffusion research, therefore, cannot tell us much about the process of diffusion over time, other than what can be reconstituted from respondents' recall data.

PROBLEMS IN DETERMINING CAUSALITY

The problem here is not just that such recall data may not be perfectly accurate (they assuredly are not), but that the cross-sectional survey data are unable to answer many of the "why" questions about diffusion. The one-shot survey provides grist for description, of course, and also enables cross-sectional correlational analysis: various independent variables are associated with a dependent variable, which is usually innovativeness. But little can be learned from such a correlational analysis approach about *why* a particular independent variable covaries with innovativeness.

"Such factors (as wealth, size, cosmopoliteness, etc.) may be causes of innovation, or effects of innovativeness, or they may be involved with innovation in cycles of reciprocal causality through time, or both they and the adoption of new ideas may be caused by an outside factor not considered in a given study" (Mohr, 1966, p. 20). Future diffusion research must be designed so as to probe the time-ordered linkages among the independent and dependent variables. And one-shot surveys can't tell us much about time-order, or about the broader issue of causality.

The pro-innovation bias in diffusion research, and the overwhelming reliance on correlational analysis of survey data, often led in the past to avoiding or ignoring the issue of causality among the variables of study. We often speak of "independent" and "dependent" variables in diffusion research, having taken these terms from experimental design and then used them rather loosely with correlational analysis. A dependent variable usually means the main variable in which the investigator is interested; in about 60 percent of all diffusion researches, this dependent variable is innovativeness, as we showed in Table 2-2. It is usually implied in diffusion research that the independent variables "lead to" innovativeness, although it is often unstated or unclear whether this really means that an independent variable causes innovativeness.

In order for variable *X to* be the *cause* of variable *Y,* (1) X must precede *Y in* time-order, (2) the two variables must be related, or covary, and (3) *X must* have a "forcing quality" on *Y.* Most diffusion researches only determine that various independent variables co-vary with innovativeness; correlational analysis of one-shot survey data does not allow the determination of time-order. Such correlational studies face a particular problem of time-order that I call "yesterday's innovativeness": in most diffusion surveys, innovativeness is measured as of "today" with recall data about past adoption behavior, while the independent variables are measured in the present tense. It is obviously impossible for an individual's attitudes or personal characteristics, formed and measured now, to have caused his adoption of an innovation three years or five years previously (this would amount to X following Fin time-order, making it impossible for *X to* cause *Y).*

Here again we see the importance of research designs that allow us to more clearly understand the over-time aspects of diffusion. Field experiments are ideally suited to the purpose of assessing the effect of various independent variables (the interventions or treatments) on a dependent variable (like innovativeness). *A field experiment* is an experiment conducted under realistic conditions (rather than in the laboratory) in which preintervention and postintervention measurements are usually obtained by surveys. In the typical diffusion field experiment, the intervention is some communication strategy to speed up the diffusion of an innovation. For example, the diffusion intervention may be an incentive payment for adopting family planning that is offered in one village and not in another (Rogers, 1973, pp. 215-217). "The best way to understand any dynamic process [like diffusion] is to intervene in it, and to see what happens" (Tornatzky et al, 1980, p. 17). Most past diffusion research has studied "what is,"

rather than "what could be"; the implication is thus that the present process of diffusion is basically satisfactory and only needs a minor tune-up, rather than a major overhaul. Roling et al (1976) heavily scored diffusion research on this count, arguing that it has often led to increased inequity in the socioeconomic consequences of innovation. Field experimental designs are needed to test alternatives to current diffusion strategies, policies, and practices, rather than just studying the "what is" of present diffusion through surveys of adopters. We recommend that *much greater use should be made of field experiments in diffusion research so as to help avoid the respondent recall problem and to evaluate policy departures from current diffusion policies.* To date, field experiments have especially been conducted by marketing scholars and by researchers investigating the effect of paraprofessional field workers and incentives in the diffusion of family planning innovations in developing nations (as explained in Chapter 2).

In order for *X to* cause *Y,* they must co-vary. If such co-variance is very low, *X is* probably not a cause of *Y.* If their common variance is high, *X may* be a cause of *Y.* Diffusion researchers have specialized in determining the correlates of dependent variables like innovativeness; this approach allows them to reject possible causes of change in a dependent variable, but it cannot tell much about the time-order of the variables or their forcing quality.

Forcing quality, the way in which *X* acts on *Y,* is a theoretical rather than an empirical issue. Much greater attention needs to be given in diffusion research to the theoretical reasoning why certain variables might have a forcing quality on a given dependent variable. Theoretical work is the key to conceptualizing the forcing quality of certain independent variables on innovativeness, and other dependent variables in diffusion research.

ALTERNATIVES TO DIFFUSION SURVEYS

Social science data-gathering techniques like the personal interview do not work very well when the researcher is asking the respondent to recall his or her previous mind-states over a long time period. For example, consider questioning a respondent as to his or her sources or channels of communication for an innovation that he or she adopted ten years previously. Or asking the respondent when he or she began to develop a favorable attitude toward the innovation. Obviously, we

would not put much faith in such data, even if they were provided by a cooperative respondent who was trying to offer valid data.

In addition to field experiments, another kind of solution to the respondent recall problem in diffusion studies is to gather data at multiple points in the diffusion process. Instead of waiting until the innovation is widely diffused to gather the data via respondents' recall, the researcher gathers data at several points during the diffusion process (see Figure 2-2). At each data point, respondents are asked whether or not they have adopted, and for the details about their innovation-decision.

In essence, such a multiple data-points approach amounts to dividing the total length of the recall period up into smaller segments for the average respondent. Thus, more accurate recall is facilitated. Unfortunately the data gathering (especially when it occurs prior to the respondent's adoption of the innovation) may intrude into that innovation decision; when one is asked repeatedly over time as to whether an innovation has been adopted, one's interest in that innovation is quite likely to be piqued. So the multiple data-gathering approach is obtrusive, even though it is compensated by certain advantages.

Another alternative solution to the respondent recall problem is the ''point-of-adoption'' study in which respondents are asked to provide details about their adoption of an innovation at the time that they adopt, such as when they come to a clinic (in the case of a health or family planning innovation), a dealer or a warehouse (such as for an agricultural innovation), or to a store (to purchase a consumer innovation, for example). This data-gathering strategy solves the recall problem, obviously, because data are gathered at the time of adoption. But it has disadvantages; for example, data about the consequences of the innovation cannot be obtained. Very few point-of-adoption studies have been conducted to date, but they might be feasible in certain situations.

In this section we have discussed various alternatives to the adopter survey, which necessarily depends mainly upon respondent recall of time of adoption (innovativeness): field experiments, longitudinal panel studies at several points in time during the diffusion process, and point-of-adoption studies. In addition, various research strategies may be used to minimize the seriousness of the respondent recall problem in diffusion surveys:

1. Select innovations for study that have recently diffused rapidly and are salient to the adopters (unfortunately, this strategy in-
- creases the possibility of a pro-innovation bias).

2. Gather data about respondents' time of adoption from alternative sources, such as archival records. An example is the Coleman et al (1966) drug study in which doctors' recall data were checked against drugstore prescription records.
3. Careful pretesting of the survey questions and high-quality interviewing by well-trained interviewers, so as to maximize the likelihood of obtaining recall data that are as valid as possible.

The Issue of Equality in the Diffusion of Innovations

As we will show in Chapter 11, diffusion researchers have not paid much attention to the consequences of innovation. They have been especially inattentive to the issue of how the socioeconomic benefits of innovation are distributed within a social system. When the issue of equality has been investigated, we often find that the diffusion of innovations usually widens the socioeconomic gap between the higher and the lower status segments of a system. This tendency for the diffusion of innovations to increase socioeconomic inequalities can occur in any system, but it has especially been noted in the developing nations of Latin America, Africa, and Asia. We therefore begin our discussion of equality issues with an examination of the geography of diffusion research.

THE GEOGRAPHY OF DIFFUSION RESEARCH

As we showed in Chapter 2, research on the diffusion of innovations began in the United States by social scientists of the "empirical school," whose work was characterized by quantitative empiricism, functionalism, and positivism (Rogers, 1981). In the late 1950s, diffusion studies were conducted by European scholars who generally followed the classical diffusion paradigm that had been pioneered by Ryan and Gross (1943).

Then, during the 1960s, diffusion research caught on in the developing nations of Latin America, Africa, and Asia. The diffusion paradigm was followed rather closely. Many of the Third World diffusion studies were conducted by sojourners from the United States or Europe, or else by Latin American, African, or Asian scholars who had learned the diffusion approach during their graduate studies in the United States. A strong stamp of "made in America" characterized these diffusion researches in the Third World. At first, during the 1960s, it seemed that most diffusion research methods and theoretical generalizations were cross-culturally valid; that is, the diffusion process in Third World nations seemed to be generally similar to its counterpart in the richer, industrialized nations of Euro-America (Rogers with Shoemaker, 1971). Even though a peasant village in the Third World was characterized by much more limited financial resources, lower levels of formal education, and a paucity of mass media, innovations seemed to diffuse in approximately the same way as in the United States. Similarities in the diffusion process were more striking than differences. For example, the rate of adoption followed the familiar S-shaped curve over time. As in the United States, innovators were characterized by higher social status, greater cosmopoliteness, and more tolerance for uncertainty than were other adopter categories in villages in Colombia (Deutschmann and Fals Borda, 1962a, 1962b) and in Bangladesh (Rahim, 1961).

But during the 1970s, questioning and critical voices began to be raised about the cultural importation of diffusion research to Third World nations. Some of the critics were Americans or Europeans who had conducted diffusion studies in developing nations; other critics were Third World social scientists (especially in Latin America), who raised troubling questions about the conduct and the results of diffusion research as it was carried out in their nations. We think these criticisms by respected diffusion scholars have a valid basis and deserve careful consideration. The key intellectual issue here is the cultural appropriateness of social science research as it originally grew to strength in the United States, and was then applied under very different sociocultural conditions in the Third World.

One reason that diffusion research is particularly subject to criticism in developing nations is because, compared to any other field of behavioral science, it received so much more attention in Latin America, Africa, and Asia. Figure 2-1 showed that even though diffusion research got under way much later in developing nations than in the United States and other developed countries, it has been catching up fast. Today, approximately 30 percent of all diffusion studies have been conducted in Latin America, Africa, and Asia.* The total

* Although there are still important gaps in the geographical scope of diffusion research, one of the most striking is the lack of much diffusion inquiry in communist nations like Russia, the People's Republic of China, and Cuba. Imagine how different the diffusion of hybrid corn on a collective farm in the Ukraine would be from the spread of this innovation in Iowa.

number of empirical diffusion research publications in developing nations increased from 54 in 1960 to 912 in 1981 (and this number is undoubtedly an underestimate). Given the large number of diffusion studies in developing nations, it is understandable that this scientific field is particularly subject to critical questioning as to its cultural appropriateness. Certain of these criticisms could be made of any type of social science research, and diffusion inquiry, owing to its ubiquity, faces the point of the intellectual attack. Certain other criticisms are special to the nature of diffusion research.

THE PASSING OF THE DOMINANT PARADIGM OF DEVELOPMENT

Around the year 1970,I think that an intellectual shift occurred in our basic conception of development. It was in this context of the passing of the dominant paradigm of development that diffusion research came to be evaluated by its critics in the 1970s, and found wanting. What is the dominant paradigm of development? There were four main elements in the dominant paradigm (Rogers, 1976).

1. *Economic growth* through industrialization and accompanying urbanization, approximately equivalent to passing through the Industrial Revolution. Development performance was quantified in such economic terms as GNP (gross national product) and per capita income. For instance, the GNP of a given nation might have increased at 5 percent per year during the 1960s; this aggregate rate of growth was taken as the index of development success without much consideration for which individuals actually got the higher incomes and who did not.
2. Capital-intensive, labor-saving *technology,* mainly transferred from industrialized nations.
3. *Centralized planning,* mainly by government economists and bankers, in order to guide and speed up the process of development. Development became the highest priority for most national governments in developing nations, once they obtained their independence from colonial powers.
4. The *causes of underdevelopment* lay mainly within the developing nation, rather than in their trade or other external relationships with industrialized countries.

The classical diffusion model fit this dominant paradigm of development quite well (as we showed previously). The paradigm of development implied that the transfer of technological innovations from development agencies to their clients lay at the heart of development. So diffusion studies began to proliferate in Latin America, Africa, and Asia, especially after about 1960.

But as a major shift occurred in the conceptualization of development in the early 1970s (Table 3-1), the role of the diffusion of innovations also began to be more widely questioned. Actually, a newer development paradigm (or paradigms) is only emerging, and there is not consensus in various nations about its exact nature. Nevertheless, emerging alternatives to the dominant paradigm of development contain certain implications for diffusion's role in development. Today, *development* is usually defined as a widely participatory process of social change in a society intended to bring about both social and material advancement (including greater equality, freedom, and other valued qualities) for the majority of people through their gaining greater control over their environment.

The much greater concern with equality of the benefits of develop-

Table 3–1. Emerging Alternatives to the Dominant Paradigm of Development.

Main Elements in the Dominant Paradigm of Development	Emerging Alternatives to the Dominant Paradigm	Possible Factors Leading to Alternatives to the Dominant Paradigm
1. Economic growth	1. Equality of distribution	1. Discouraging rates of economic growth during the 1950s and 1960s in most developing nations. 2. A growing loss of faith in the "trickle-down" theory of distributing development benefits.
2. Capital-intensive technology	1. Improving the quality of life 2. Greater emphasis on appropriate technology.	1. Environmental pollution problems in Euro-America and Japan. 2. Realization that there are limits to growth. 3. The post-1973 energy crisis.
3. Centralized planning of development	1. Self-reliance in development at the local level.	1. The experience of the People's Republic of China with decentralized, participatory development, which became widely known elsewhere in the 1970s.
4. Mainly internal causes of underdevelopment	1. Internal and external causes of underdevelopment (amounting to a redefinition of the problem by developing nations).	1. The rise of OPEC power. 2. Shifts in world power, illustrated by voting behavior in the UN General Assembly and in various international bodies.

ment in the 1970s pointed toward the priority of villagers and urban poor as the main target audience for development in developing nations. This audience represented the majority of a nation's population in most developing countries. Development policies had to become less elite-oriented, and more concerned with equalizing the socioeconomic benefits of technological innovations. When concerns about equity in development programs had been raised prior to the 1970s, they were often answered in terms of the "trickle-down" theory, that certain sectors of society would lead in adopting technological innovations but that these benefits would soon be passed down to the lagging sectors. The trickle-down theory was rejected, however, by development planners in the 1970s as just an excuse for not directly attacking the socioeconomic inequities owing to the social structure of developing nations.

APPROPRIATENESS OF THE DIFFUSION PARADIGM TO DEVELOPING NATIONS

An eminent Latin American communication scholar who has conducted diffusion research for over twenty years on his continent, Dr. Juan Diaz Bordenave (1976), concluded that "Latin American communication scholars must overcome their mental compulsion to perceive their own reality through foreign concepts and ideologies, and they must learn to look at the communication and adoption of innovations from their own perspective." Because the classical diffusion model was formulated under quite different socioeconomic conditions, and by scholars with an ideological position not compatible with the Latin American reality, Bordenave (1976) argues that the diffusion research questions asked by Latin American researchers do not get to the main issues affecting development. Specifically, the typical research issues in past diffusion studies have been:

1. How are technological innovations diffused in a social system?
2. What are the characteristics of innovators, early adopters, and other adopter categories?
3. What is the role of opinion leaders in the interpersonal networks through which a new idea diffuses in a system like a peasant village?

Bordenave (1976) suggests that the following research questions are more appropriate to the needs of a government official who is

planning for a more just social structure as the result of national development programs:

1. What criteria guide the choice of innovations that are to be diffused: (1) the public welfare, (2) increased production of goods for export, (3) maintaining low prices for urban consumers, or (4) increased profits for society's elites like large landowners and industrialists?
2. Who decides which innovations should be developed by R&D workers, and diffused to adopters?
3. What is the nature of the society's social structure, and what influence does it have over individual innovation-decisions?
4. Are the technological innovations being diffused appropriate, well proven, and adequate for the stage of socioeconomic development of the nation? Are the innovations designed especially for commercial farmers or for subsistence peasants, for elites or for the urban poor?
5. Who controls the communication sources and channels by which the innovations are to be diffused? Is there monopoly, censorship, blockage, or distortion of innovation messages in the present communication system?
6. What are the likely consequences of technological innovation in terms of employment and unemployment, migration of rural people to already overcrowded cities, and to a more equitable distribution of individual incomes? Will the innovation widen or narrow socioeconomic gaps?

These important issues have seldom been addressed by diffusion research in Latin America, nor in Africa or Asia. Perhaps they also should be considered for study in nations like the United States. These questions promise to carry diffusion research in directions that would help overcome the pro-innovation bias and individual-blame assumptions. Perhaps the most important single way in which diffusion research in developing nations should be different from the past is in regard to the equity issue, especially as diffusion is affected by a rigid social structure in developing nations.

SOCIAL STRUCTURE AND DIFFUSION

In Latin America, Africa, and Asia, the social structure of a nation or of a local community is often in sharp contrast to that in Euro-America. Power, economic wealth, and information are usually more highly concentrated in a few hands, and this aspect of social structure

affects not only the nature of an innovation's diffusion but also who reaps the main advantages and disadvantages of such technological change. If innovations diffused more rapidly, but if the basic socioeconomic inequities reflected in the social structure were not changed, had development really occurred?

Third World scholars in the 1970s began to question whether the classical diffusion model, even if it were cross-culturally valid in its functioning, was contributing much to development. The issue was not simply one of putting social structural variables into diffusion analyses, nor even just one of a wider sharing of the consequences of innovation, but of a change in the very social structure of society. In other words, a social revolution. The social problem of underdevelopment was thus being redefined, and along lines that seriously questioned whether the diffusion of innovations could play an important role in changing the social structure of society.

The classical diffusion model was conceived in sociocultural conditions that were substantially different from those in Latin America (or Africa and Asia), and hence, Bordenave (1976) argued, when the model was used uncritically, it did not touch such basic issues as changing the social structure in these countries: "If there is one thing we are learning in Latin America, it is that studies of the communication of innovations cannot exist as ideologically free and politically neutral research. The scientist who says that he wants to do research without committing himself to any of the ways of changing … society is, in fact, as ideologically committed as the one who believes in research as a tool for forging his chosen path to human and social change."* In Latin America, and in Africa and Asia, diffusion research has tended to ignore the social structural context in which it is conducted. This criticism is also true in the United States, but perhaps its results are less serious.

Constructive critics of the basic assumptions of the diffusion approach have questioned whether "communication itself can generate development regardless of socio-economic and political conditions" (Beltran, 1976). Instead, these scholars argue that the diffusion of innovations can have little effect "unless structural changes come first to initiate the development process" (Grunig, 1971). In fact, the mass

*This viewpoint that communication research and communication researchers are themselves a part of the society they study, has been more fully recognized by certain European and Latin American critical scholars than by their North American counterparts, who tend to think of empirical research as neutral and valuefree (Rogers, 1981a). Critical communication scholars raise the important question: how valuable is it to be scientifically precise in studying a problem in a way that doesn't matter?

media in many developing nations do not carry useful information about technological innovations to the majority of the population who are villagers and urban poor (Barghouti, 1974). Media content is mainly devoted to entertainment and advertising, content that may actually work against development, especially rural development. The media are often owned by a minority elite, and devoted to urban issues and to increasing the consumption of consumer products, thus diverting public attention from the issues of sociopolitical structural change.

So, in moving beyond its pre-1960 "Made in the U.S." origins through transfer to developing nations in the 1960s and 1970s, diffusion research came to be perceived in a different perspective, and judged by the criteria of different objectives. A means to social revolution it is not. A helpful tool for social change and development, when accompanied by a basic restructuring of society, it may be.

SOCIOECONOMIC GAPS AND DIFFUSION

The social structure in developing nations has been found to be a powerful determinant of individuals' access to technological innovation; often, structural rigidities must be overcome before the communication of innovations can have much effect (Bordenave, 1976). For example, farmers who own larger farms than most others, who enjoy a higher socioeconomic status, and who have more ample mass-communication opportunities, are most innovative in adopting new agricultural technologies. Perhaps a farmer's failure to adopt innovations is due more to a lack of opportunities, rather than to an in-built traditional resistance to change. Farmers with more land, more money, and more knowledge can more easily obtain credit, further information, and other inputs to adopt technical innovations. Since they adopt innovations relatively earlier, they gain more of the benefits of innovations, such as "windfall profits" that accrue especially to innovators. The majority of poorer farmers in developing nations lack resources and either cannot adopt innovations or else must adopt relatively later. Most farmers in developing nations simply are not free to implement their own innovation decisions.

Development agencies tend to provide assistance especially to their innovative, wealthy, educated, and information-seeking clients. Following this progressive (or "easy-to-convince") diffusion strategy leads to less equitable development. For example, more progressive farmers are eager for new ideas, and have the economic means to

adopt; they can also more easily obtain credit if they need it. Because they have large-sized farms, the direct effect of their adoption on total agricultural production is also greater. Rural development workers follow this progressive client strategy because they cannot reach all of their clients, so they concentrate on their most responsive clients, with whom they are most homophilous. In other words, individuals who have greater resources usually benefit more from the innovations introduced by development agencies than those individuals who have fewer resources, thus widening the socioeconomic benefits gap.

But does the diffusion of innovations necessarily have to widen socioeconomic gaps in a social system? Some reason for optimism on this issue has been provided by two field experiments in developing nations. Shingi and Mody (1976) in India and Roling et al (1976) in Kenya designed and evaluated diffusion approaches that narrowed, rather than widened, socioeconomic gaps. Essentially, these approaches sought, with some success, to overcome the inequity bias of usual diffusion programs; they introduced appropriate innovations to lower socioeconomic clients via a special kind of development program. These two studies (which will be detailed in Chapter 11) suggest that if communication strategies are used effectively in narrowing the socioeconomic benefits gap, then the socioeconomic structure may no longer be such a major barrier to the diffusion of innovations for the most disadvantaged segment of the population. Thus, it may be possible to bring about *a* more equitable development through appropriate diffusion strategies, even when social structural changes at the macrolevel have not occurred.

We have just reviewed four of the major shortcomings of diffusion research; they lead us to conclude that the beginnings of diffusion research left an indelible stamp on the approaches, concepts, methods, and assumptions of the field, some 40 years and 3,000 publications later. The biases that we inherited from our research ancestors have been quite inappropriate for the important diffusion research tasks of today. It is ironic that the study of innovation has itself been so traditional.

Generalizing about Diffusion Via Meta-Research

The meta-research used to synthesize 103 generalizations about diffusion by Rogers with Shoemaker (1971) has been criticized by Downs and Mohr (1976) for what they consider its lack of highly consistent findings.* We shall discuss this criticism shortly, but first we explain how one draws knowledge at a more general level from empirical studies of diffusion. Most readers of this book want to learn what is generally known about the diffusion of innovations, rather than just the details of how water boiling spread in a Peruvian village, how gammanym diffused to medical doctors, and how modern math was adopted by schools in Pittsburgh. With this need for more abstracted understandings of diffusion in mind, the present book is organized around a series of ninety-one generalizations. They result from *meta-research,* the synthesis of empirical research results into more general conclusions at a theoretical level (Rogers, 1981b). The main method of meta-research used here is the propositional inventory, in which the written conclusions from each empirical research are tabulated in a series of propositions and then more general conclusions are drawn in the form of generalizations.

Meta-research can provide scientific information that cannot be obtained in any other way. Let us assume that there are one hundred empirical studies on the relationship of socioeconomic status and innovativeness (there are actually several hundred). Each of the one hundred researches may have measured status and innovativeness in somewhat different ways. In some studies the respondents are farmers, in others they are educators, in other cases medical doctors, and so forth. Would you like to read all one hundred diffusion publications, and draw your own conclusions? You would likely get lost in the information overload caused by the huge Rile, of research publications. And the overall generalization might not be very clear-cut, unless you read the reports carefully and categorized their findings in a propositional inventory. In essence, I have helped guide your way through the maze by diffusion research literature by synthesizing the ninety-one generalizations around which future chapters of this book are organized.

Meta-research is uniquely able to provide information about the reliability of a research finding across a number of studies. Most of us want more than a single study to provide confirmatory evidence about

* Schmidt (1976) also criticized the 103 generalizations in Rogers with Shoemaker (1971) for their lack of very complete support, but then he argued for the importance of explaining why a generalization is supported in certain empirical studies and not in others. In fact, Schmidt seeks to bring his theoretical approach (based on the German sociologist K. D. Opp and the work of George Homans) to bear in explaining certain of the 103 generalizations.

a particular research finding, as a single research study is a rather thin reed upon which to base a policy or practice. So knowing the reliability of the research evidence for some generalization as a result of meta-research is usually a necessary step in translating research results into practice. Only rarely can the knowledge provided by a single research study lead us directly to solving some social problem.

Now we shall describe the meta-research steps through which we derived the ninety-one generalizations about the diffusion of innovations in this book.

Relating Theory and Research at the Middle Range

We prefer to operate at the "middle range,"* relating theory to research and research to theory. This means that our theoretical basis must be specific enough to be empirically testable, and our data must test theoretical hypotheses. Theory that cannot be tested is useless, and data that are not related to theoretic hypotheses become irrelevant. The essential procedural steps in our meta-research at the middle range are:

1. All concepts must be expressed as variables. A *concept* is a dimension stated in its most basic terms. A conceptual variable used throughout this book is innovativeness, defined as the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system. Ideally, a concept should be as general or abstract as possible so that it may be used to describe behavior in many different types of social systems. For example, the innovativeness concept has been studied in industry, education, medicine, and agriculture.

2. The postulated relationship between two (or more) concepts is called a *theoretical hypothesis.* An example of a theoretical hypothesis tested in several research studies (that will be cited in Chapter 7) is: "Innovativeness is positively related to cosmopoliteness." In this example, innovativeness and cosmopoliteness are concepts, and the theoretical hypothesis postulates a positive relationship between them. The hypothesis states that individuals who have communication with sources external to their system are more innovative. If one has

*This idea comes from Merton (1968) who asks for "theories of the middle range," that is, postulated relationships that are testable but that deal with only a rather limited, particular type of behavior. These middle-range theories may eventually be consolidated into more abstract general conceptual schemes.

network links with others outside of a social system, greater deviation from that system's expectations for one's behavior is likely, and the adoption of new ideas probably results. Also, the cosmopolite network links may provide a channel through which one may learn about innovations.

Notice that the theoretical hypothesis illustrated here is limited in scope to the diffusion of innovations. That is why our type of analysis is termed "middle range"; application of our hypothesis is explicitly confined to one type of human behavior. Such limitation, however, should encourage the postulation of similar hypothesized relationships dealing with other types of behavior; middle-range analysis can offer one route toward more general theories.

3. A theoretical hypothesis is tested by means of an *empirical hypothesis* (or hypotheses), defined as the postulated relationship between two operational measures of concepts. An *operation* is the empirical referent of a concept; it may be an index, an observation, or the answer to a single direct question. Whereas concepts exist only at the theoretical level, operations exist only at the empirical level. The degree to which an operation is a valid measure of a concept is called an *epjstemic relationship.* The isomorphism of this linkage between a concept and its operation can be evaluated only by intuitive means.

A middle-range analysis of the relationship between innovativeness and cosmopoliteness is illustrated by an example from the Ryan and Gross (1943) hybrid corn study (Figure 3-6).

4. An empirical hypothesis may be accepted or rejected on the basis of statistical tests of significance, by visual observation of the data, or according to other criteria. In the hybrid corn study, Ryan and Gross (1943) report a positive, significant relationship between a

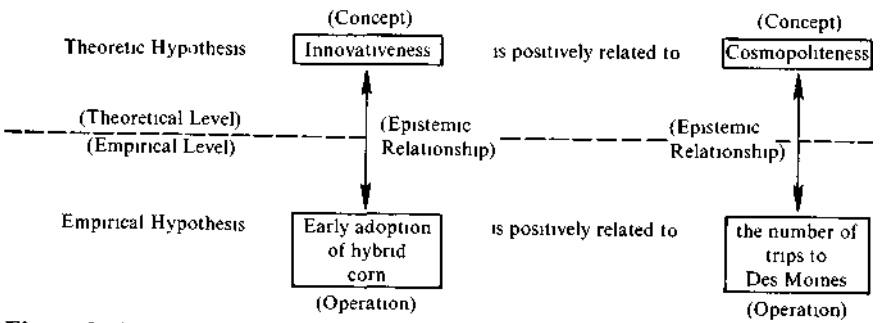

Figure 3-6. Diagram of a middle range analysis of innovativeness and cosmopoliteness.

farmer's time of adoption of hybrid seed and his number of trips to Des Moines.

5. A theoretical hypothesis is supported or rejected on the basis of the tests of corresponding empirical hypotheses. Truth claims may be added to a theoretical hypothesis by similar findings from other analyses of the two conceptual variables in a variety of different social systems. As additional support is added to a general hypothesis, greater confidence may be placed in the relationship between the two concepts, and this relationship may be considered a *generalization* and eventually perhaps a *principle* or even a *law.* Generalizations, principles, and laws represent three points on a continuum that indicates the degree of validity established for a relationship between two or more concepts.

6. The relationships between each of the two concepts and other concepts may be analyzed, and, as findings of this nature gradually accumulate, a more general body of theory is developed. Evidence is accumulated in an integrated and consistent manner. For instance, Coleman et al (1966) found that innovative doctors in adopting a new drug made more trips to out-of-town medical-specialty meetings. This finding, and many others reported in Chapter 7, lend further support to the generalization about innovativeness and cosmopoliteness.

We relate the theoretical and empirical levels by the joint processes of *deduction* (going from theoretical to empirical hypotheses) and *induction* (from empirical results to the conceptual level.) The eventual goal of middle-range analysis is the development of an interrelated, integrated series of concepts, linked in a matrix of theories and of established relationships.

In the present book we fit a great number of empirical relationships that resulted from diffusion investigations into a series of middle-range generalizations. These generalizations form the organizational skeleton of our book.

The Oversimplification of Two-Concept Generalizations

One shortcoming of our generalizations in the following chapters is the deceit of their neatness and simplicity. Our generalizations deal almost entirely with pairs of concepts, whereas the real nature of diffusion is certainly a cobweb of interrelationships among numerous conceptual variables. For instance, our generalization that innovativeness is positively related to cosmopoliteness (Figure 3-2) does not indicate that the relationship between innovativeness and cosmopoliteness *may* be due to the relationships of both variables with a third concept such as social status. We know, for example, that more innovative individuals are often of relatively higher socioeconomic status, as are cosmopolites (Chapter 7). Then should not social status also be included in the innovativeness-cosmopoliteness generalization? Unfortunately, it cannot be. Most of the empirical diffusion studies reviewed in this book focus upon only two-variable hypotheses, and we cannot summarize findings that do not exist. Further, the ability to understand three-variable, four-variable, and so on generalizations usually suffers in direct proportion to the number of variables included.

Therefore, for the sake of clarity and because we lack an empirical basis to do otherwise, the generalizations in this book, with only a few exceptions, deal with two concepts. We should not forget that we are artificially and heuristically chopping up reality into conceptual bite-sized pieces. Although such processing may aid digestibility, it also adds an ersatz flavor.

The Reliability of Diffusion Generalizations

Middle range analysis is not only useful in synthesizing past research findings, but it also provides useful leads for future diffusion inquiry. In several chapters of this book that deal with topics where relatively little past investigation has been done, our generalizations possess few claims to truth. In these cases our generalizations more closely resemble a research map for future studies than a summary of past results. The generalizations in this book range in their degree of existing research support from very little, where the generalizations are not much more than theoretical hypotheses, to a great deal, where the generalizations approach the level of principles.

The number of empirical diffusion studies bearing upon each of our generalizations in this book is provided in the following chapters. This tabulation is based upon our content analysis of all empirical diffusion publications available in 1968 (Rogers with Shoemaker, 1971, pp. 346-385), reorganized, reclassified, and updated in several cases to reflect current changes in the directions of diffusion research since 1968. For example, most of the generalizations about innovation in

organizations (Chapter 10) are based upon research conducted since 1968. In other cases, such as the generalizations about variables related to innovativeness (Chapter 7), the available diffusion research has not changed direction in important ways since 1968, so we feel fairly safe in mainly relying on our earlier content analysis. Since 1968, the total volume of diffusion publications about innovativeness has approximately doubled, and the task of content analyzing all of the more recent studies would be so large as to be discouraging. But I have read each of these post-1968 diffusion publications that are now available, and have intuitively brought their findings into the present book.

Not surprisingly, the empirical support for the generalizations in this book varies rather widely. Some generalizations are supported by a fairly high percentage of the relevant empirical studies, ranging up to 60 or 70 or even 80 percent in many cases. Is this a satisfactory level of reliabiltiy? Downs and Mohr (1976), after reviewing the reliability of diffusion generalizations in my previous diffusion book (Rogers and Shoemaker, 1971), did not think so: "Perhaps the most alarming characteristic of the body of empirical study of innovation is the extreme variance among its findings, what we call instability.. . . This phenomenon occurs with relentless regularity. One should certainly expect some variation of results in social science research, but the record in the field of innovation is beyond interpretation."

We are not entirely convinced by Downs and Mohr's dire view of the reliability of diffusion generalizations. When I have compared the reliability of our present generalizations with those in other fields of social science, biological science, and physical science, I do not find them to be less reliable. So if the comparison is relative, diffusion generalizations are as reliable as those in other research fields, especially given the diverse range of scientific disciplines, methodologies, and types of innovations and adopting systems involved in diffusion research. In an absolute sense, there is no exact standard on which to judge the reliability of diffusion generalizations. But like Downs and Mohr (1976), I generally wish for higher levels of agreement in the findings from diffusion research.

And one step in achieving such higher reliability is to make a propositional inventory of the diffusion field like the present book, so that we know how we stand, and to help identify priority directions for future study. It is in this sense that we offer the meta-research in this book.

Summary

In this chapter, we discussed four major criticism of diffusion research: (1) *its pro-innovation bias,* the implication of most diffusion research that an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither re-invented nor rejected; (2) the *individual-blame bias,* the tendency to hold an individual responsible for his or her problems, rather than the system of which the individual is a part; (3) the *recall problem* in diffusion research that may occur owing to inaccuracies when respondents are asked to remember the time at which they adopted a new idea; and (4) the *issue ofequality* in the diffusion of innovations, as socioeconomic gaps among the members of a social system are often widened as a result of the spread of new ideas. Alternatives to usual diffusion research approaches were proposed for overcoming each of these four criticisms of diffusion research.

Finally, we describe the meta-research procedures through which the generalizations in this book were derived. *Meta-research* is the synthesis of empirical research results into more general conclusions at a theoretical level. The first step in this approach is to explicate all concepts. A *concept* is a dimension stated in its most basic terms. Next, we postulate a relationship between two concepts in the form of a *theoretical hypothesis.* A theoretical hypothesis is tested by a corresponding *empirical hypothesis,* which is the postulated relationship between two operational measures of concepts. An *operation* is the empirical referent of a concept. Empirical hypotheses are often accepted or rejected on the basis of statistical tests of significance, but other criteria may be used. Finally, a theoretical hypothesis is supported or rejected by testing its corresponding empirical hypotheses, resulting eventually in a series of middle range generalizations. We believe that middle range generalizations are the stepping stones to more general theories of human behavior change, once they are abstracted to a yet higher level of generality.

CHAPTER 4

The Generation of Innovations

Ben-Adhem picked up a stone from beside the road. Written on it were these words: "Turn me over and read " He picked it up and looked at the other side. There was written, "Why do you seek more knowledge when you pay no heed to what you know already?"

I Shah (1968), *Caravan of Dreams,* p 110

The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumer's goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates.

Joseph A Schumpeter (1950), *Capitalism, Socialism, and Democracy*

THIS CHAPTER is CONCERNED WITH where innovations come from, and how their origins cast a later influence on their diffusion and consequences. As we pointed out in Chapter 3, all past diffusion studies began with the left-hand tail of the S-shaped diffusion curve, that is, with the first adopter of an innovation. As we showed in Figure 3-4, the decisions and events occurring previous to this point have a strong influence on the diffusion process. In this wider-scope view of the innovation-development process, diffusion is but one phase of the total sequence through which an innovation goes from the decision to begin research on a recognized problem to the consequences of an innovation.

Past diffusion investigations have overlooked the fact that a great deal of relevant activities and decisions usually occurred long before

the diffusion process began: a perceived problem, funding decisions about R&D activities that led to research work, invention of the innovation and then its development and commercialization, a decision that it should be diffused, transfer of the innovation to a diffusion agency, and its communication to an audience of potential adopters. *Then* the first adoption occurs.

This entire prediffusion series of activities and decisions is certainly an important part of the innovation-development process, of which the diffusion phase is one component. The importance of what happens prior to the beginning of an innovation's diffusion (especially those events that affect the nature of diffusion later on) has been almost entirely ignored in past diffusion research. This serious deficiency in previous diffusion investigations should be overcome.

We shall review in this chapter some of the researches that have been completed on these prediffusion aspects of the technology-development process. Unfortunately, there are relatively few such investigations of the early phases in the technology-development process. As a result, our grasp of the topics in this chapter are necessarily more tentative than in the rest of this book.

The Innovation-Development Process

In Chapter 1, we defined an *innovation* as an idea, practice, or object that is perceived as new to an individual or another unit of adoption. The *innovation-development process* consists of all of the decisions, activities, and their impacts that occur from recognition of a need or problem, through research, development, and commercialization of an innovation, through diffusion and adoption of the innovation by users, to its consequences. Now we take up each of the main steps in the innovation-development process.

/. *Recognizing a Problem or Need*

One of the ways in which the innovation-development process begins is by recognition of a problem or need, which stimulates research and development activities designed to create an innovation to solve the problem/need (Figure 4-1). In certain cases, a scientist may perceive a forthcoming problem and launch research to find a solution. An ex-

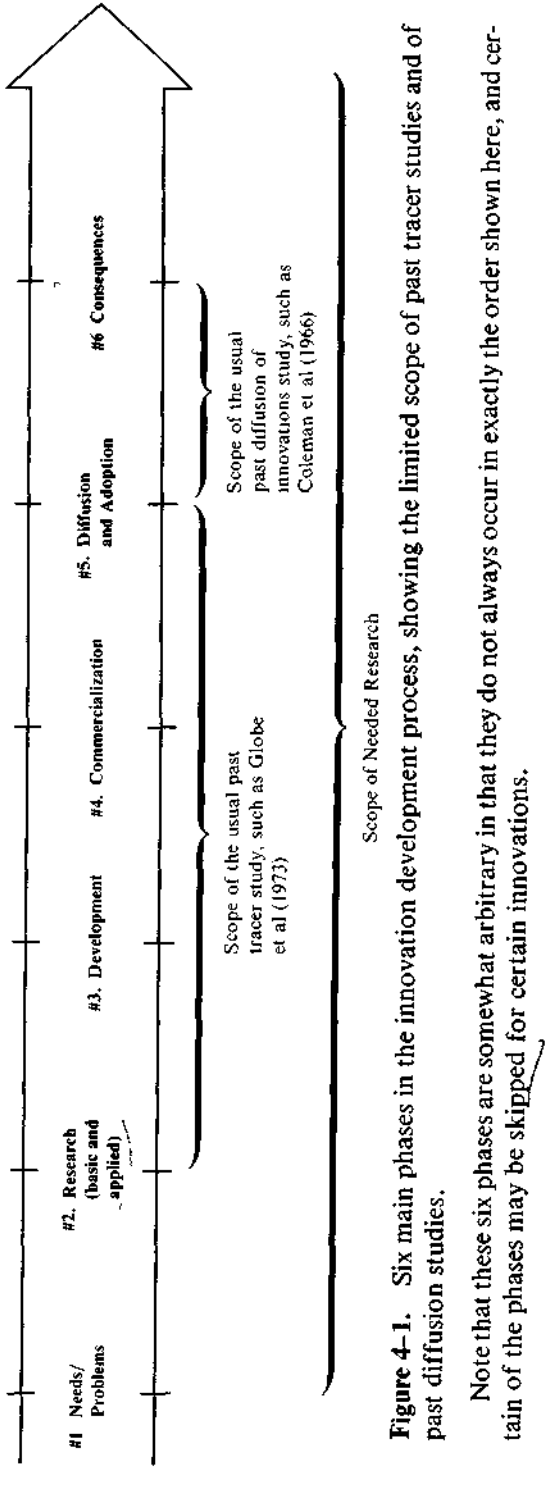

Figure 4–1. Six main phases in the innovation development process, showing the limited scope of past tracer studies and of past diffusion studies.

Note that these six phases are somewhat arbitrary in that they do not always occur in exactly the order shown here, and certain of the phases may be skipped for certain innovations.

ample is the agricultural scientist at the University of California at Davis who foresaw a severe labor shortage for California tomato farmers when the *bracero* program ended, and initiated an R&D program to breed hard tomato varieties that could be machine picked (we describe this case illustration in a following section).

In other cases, a problem/need may rise to high priority on a system's agenda of social problems through a political process, as was illustrated in Chapter 3 in the case of automobile safety. Research and development to develop safer cars and highways had been conducted and accumulated for several years, but the results were not put into practice until the mid-1960s when a series of highly publicized legislative hearings and Ralph Nader's (1965) book, *Unsafe at Any Speed,* called national attention to the high rate of traffic fatalities. The social problem of auto safety rose to a high national priority owing to higher fatality rates in the early 1960s, when the annual death rate reached 50,000. But the interpretation of this dangerous trend was in large part a political activity.

Havelock (1972) conducted a survey (1) of several hundred researchers specializing in auto safety, and (2) of several hundred decision makers who were members of the most prominent national highway safety organizations. The decision makers generally shared the conventional view of the traffic safety problem: that it was due to "the nut behind the wheel" (an individual-blame perspective). On the other hand, most of the research community rejected this "old guard" view of the safety problem and felt that solutions had to come from the redesign of autos and highways (a system-blame view). The invisible college of safety researchers working mainly in universities, was led by a cadre of research opinion leaders who were seen by their peer-researchers as conducting the most important research in the field. These opinion leaders had a high degree of contact with decision makers, who tended to be government officials or executives in private firms such as insurance companies. As a result, the old guard's perception of the traffic safety problem as due to the nut behind the wheel was giving way to a system-blame perspective of this social problem. Safety research was thus being redirected, and new public policies were being formed to effectuate safer cars and roads. Eventually, a federal law was passed (1) requiring auto makers to design safer cars, and (2) forcing the highway construction industry to build safer roads.

In this case, existing research results were put into use through a political process. And traffic safety researchers helped call attention

to the social problem by means of their research, which led to the redefinition of the problem from one of individual-blame to system-blame.

2. Basic and Applied Research

Most innovations that have been investigated in diffusion researches have been technological innovations, and so the term "technology" is often used as a synonym for innovation. What is a technology? As we stated in Chapter 1, *technology* is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome. A technology usually has hardware and software components. Our definition implies some need or problem. The tool has (1) a material aspect (the equipment, products, etc.), and (2) a software aspect, consisting of knowledge, skills, procedures, and/or principles that are an information base for the tool. Almost every technology embodies software aspects, although they are often less easily visible than the hardware aspects. Some technologies are almost purely software in nature; an illustration is Henry Ford's idea of assembly-line manufacturing, or the Japanese management concept of quality-control circles. These are mainly social technologies.

As explained previously, most technological innovations are created by scientific research activities, although they often result from an interplay of scientific method and practical operations. The knowledge base for a technology usually derives from *basic research,* defined as original investigations for the advancement of scientific knowledge that do not have the specific objective of applying this knowledge to practical problems. In contrast, *applied research* consists of scientific investigations that are intended to solve practical problems. Scientific knowledge is put into practice in order to design an innovation that will solve a perceived need or problem. Applied researchers are the main users of basic research.

Thus, an invention* may result from a sequence of (1) basic research followed by (2) applied research leading to (3) development. One measure of the success of research is whether or not it leads to a patent, through which the federal government legally protects the rights of the inventor for a period of seventeen years. The patent

* *Invention* is the process by which a new idea is discovered or created. In contrast, innovation (as defined previously) occurs when a new idea is adopted or used.

clause was introduced in the U.S. Constitution by our nation's founding fathers in order to provide a capitalistic motivation for invention. A patent guards the rights of an inventor during the period in which the new idea is being commercialized (that is, converted into a new product for sale). In order to be awarded a patent, an inventor must prove to the U.S. Patent Office that his or her new idea is genuinely original, that it does not overlap with any existing knowledge.

Once a patent is granted and published, the public, of course, knows the details of the new idea. In high-technology industries like the semiconductor electronics firms in Silicon Valley, California, many new ideas are *not* patented in order to prevent a firm's competitors from learning of a technological innovation. The inventing firm fears that competitors will "invent around" the patented idea, and thus take advantage of the technological knowledge represented by the patent, without having to pay for obtaining it. Thus, a patent can sometimes encourage application and diffusion of a new idea, as well as restricting such use of the patented knowledge. Ordinarily, however, an inventor will sell a license to use the new idea for an initial fee plus a royalty which is usually a percentage of sales). Many important research findings are not patented, of course, and many of those that are patented are not licensed, because no one has devised a profitable application for the new idea. For example, the U.S. government has sponsored research leading to about 30,000 patents, but only about 1,500 are licensed at present.

We do not yet generally understand the role of the patenting of innovations in the process of innovation development. Study is needed on how a patent facilitates or restricts the application of scientific findings to form useful innovations.

3. Development

The acronym R&D corresponds closely to the concept that it represents": "R" always appears together with "D" and, moreover, always precedes "D"; development is always based on research. In fact, it is usually difficult or impossible to separate research and development, which is why the term "R&D" is so often used. But for present purposes at least in a heuristic sense, we argue that research and development are distinct phases in the innovation-development process.

Development of an innovation is the process of putting a new idea in a form that is expected to meet the needs of an audience of potential

adopters. This phase customarily occurs after research but prior to the innovation that stems from research. In the case illustration of the mechanized tomato harvester, the innovation was developed by agricultural researchers at the University of California at Davis. They designed a tomato-harvesting machine and built a prototype model, but then they contracted with a farm machinery company to manufacture the mechanized harvester. This later phase is called commercialization, and will be discussed in the following section.

THE ROLE OF UNCERTAINTY IN R&D

If the adopter of an innovation is faced with a high degree of uncertainty, the inventor-developer of a new idea must cope with even greater uncertainty. The inventor-developer must understand not just his or her own problems (as an innovation-adopter must do), but also the problems of various other individuals and organizations who will be the ultimate adopters of the innovation that he or she is creating. In addition, the behavior of others in his or her own R&D organization, his or her competitors, government policy makers, and a host of others may all affect the success of an inventor's new idea. The system of information exchange about technological innovation is thus a crucial component affecting innovation. R&D workers must devote much effort to obtaining and using information: data about *the performance* of the innovation they are seeking to create and market, about the materials and components they are fabricating into the innovation, information about competitors' innovations, the nature of existing patents related to their proposed innovation, government policies affecting their proposed innovation, and the problems faced by consumers in their market and how the proposed innovation might help solve certain of these perceived problems.

So the innovation-development process is, most of all, driven by the exchange of technical information in the face of a high degree of uncertainty. This point is illustrated by the case of the U.S. semiconductor industry, which is highly concentrated in the Silicon Valley of Northern California, a ten-by-thirty-mile area between San Francisco and San Jose. All but three of the approximately seventy-five American semiconductor firms are located in Silicon Valley. Why? The main reason is because the semiconductor business is a high-technology industry characterized by continuous innovation, as a larger and larger number of computer functions are put on a tiny silicon chip as big as one's little fingernail. In order to compete in the semiconductor industry, the electronics engineers who work in it must exchange information with the other R&D workers in competing firms. Thus, Silicon Valley is an information system for the exchange of technical knowledge. Naturally, a semiconductor company wishes to prevent its technological secrets from spreading to its competitors by means of patents, security against industrial espionage, and by other means. But there is a 30 percent job-mobility rate among Silicon Valley R&D workers, which shows us that one means of obtaining another firm's technical secrets is to hire one of its key engineers. Of course, there is a counter-strategy: the other firm may rehire its original employee six months or a year later, when he knows many of the competitor's technical secrets (Rogers et al, 1980b).

DEVELOPMENT OF A NEW HIGH-TECHNOLOGY INDUSTRY

The case of the Silicon Valley semiconductor industry illustrates how certain industries grow up around the introduction of a radical new product. Such a major innovation often gives rise to the development of an entirely new industry. Mueller and Tilton (1969) point out that a sequential process occurs: "A new industry is created by a *major process* or product innovation, and develops technologically as less radical, follow-on innovations are introduced." Four phases typically occur in the development of a new high-technology industry:

1. *Innovation,* a period of very high uncertainty where trial-and-error problem solving leads to the innovation, with makeshift production in a small facility such as a garage. A few new firms are founded and the industry begins.
2. *Imitation,* when there is decreasing uncertainty as many new firms enter the industry and develop their own variants of the basic innovation, which is gradually improved through R&D and by closer attention to marketing. The new firms are often spinoffs from existing companies in the industry, in which an entrepreneur with a "hot idea" for a new product launches a firm to produce it. Most of the Silicon Valley semiconductor firms were spinoffs from Fairchild Semiconductor, one of the first firms in the industry (Rogers et al, 1980b).
3. *Technological competition,* where R&D laboratories improve the innovation through production-process changes, while smaller firms find it difficult to enter the industry and competition eliminates existing firms that cannot succeed in making important improvements on the basic innovation.
4. *Standardization,* where the ideal product has been found and

R&D activities concentrate on improving the production process and on prolonging the product life cycle, and where technological competition has shifted to price competition (Baker and Sweeney, 1977, pp. 119-123).

Table 4-1 shows these four phases with illustrative industries of each. These industries are all examples of high-technology industries that were founded on the basis of a radical innovation. The solar industry presently seems to be in the imitation stage, as the basic innovation of the solar flat-plate collector is gradually improved through the closer interface of R&D and marketing. In contrast, the semiconductor industry seems to be in the third stage of technological competition. Large investments are made in R&D in order to advance the innovation; the original, basic innovation of putting a computer on a chip is now being modified to put larger and more powerful computer functions on a chip. Stiff barriers exist to the entry of new firms into the semiconductor industry, and competition has eliminated many existing firms in recent years.

The stage in the development of an industry affects the nature of innovation behavior. As a new industry moves from the first phase of

Table 4-1. Stages in the Technological Development of a New Industry around a Radical Innovation.

Stage in the Technological Development of a New Industry	Representative Industries
1. *Innovation,* a period of very high uncertainty in which trial-and-error problem solving leads to the innovation, with makeshift production in a small facility.	1. Bioengineering industry, in which the basic invention of recombinant DNA is applied.
2. *Imitation,* when there is decreasing uncertainty as many new firms enter the industry and develop their own variants of the basic innovation, which is gradually improved through R&D and by closer attention to marketing.	2. Solar-collector industry, built around the basic idea of the solar flat-plate collector.
3. *Technological competition,* where R&D laboratories improve the innovation through process changes, while smaller firms find it difficult to enter the industry and competition eliminates existing firms that cannot succeed in making important improvements on the basic innovation.	3. Semiconductor industry.
4. *Standardization,* where the ideal product has been found and R&D activities concentrate on improving production and on prolonging the product life cycle, and where technological competition has shifted to price competition.	4. Pocket-calculator industry.

innovation, to imitation, to technological competition, and finally to standardization, we expect:

- Uncertainty about the innovation to decrease.
- Average firm size to increase.
- The R&D function to become more formalized.
- The influence of marketing on R&D to increase.
- The innovation to become more standardized in the industry.

4. Commercialization

Innovations often result from research activities; they thus represent scientific results packaged in a form ready to be adopted by users. Because such packaging of research results is usually done by private firms, this stage in the technology-development process is usually called "commercialization." *Commercialization* is the production, manufacturing, packaging, marketing, and distribution of a product that embodies an innovation.

Not all innovations come from research and development, of course. They may instead arise from practice as certain practitioners seek new solutions to their needs/problems. For example, most medical innovations are the product of research and development activities by specialized experts, but occasionally an innovation comes from practice. An illustration is radial keratotomy, a surgical procedure for correcting certain eyesight problems.* This innovation was adopted by several thousand practitioners before its scientific evaluation was begun by the National Institutes of Health (NIH). Another illustration is laetrile, a substance that was purportedly a cure for cancer, until it was subjected a few years ago to clinical trials to determine its effectiveness. There are similar examples of innovations coming out of practice in education, public transportation, agriculture, and other fields.

Two or more innovations are often packaged together in order to facilitate their diffusion because the several innovations have a functional interrelatedness, or at least they are so perceived by potential adopters. A *technology cluster* (also called an innovation package in Chapter 5) consists of one or more distinguishable elements of technology that are perceived as being interrelated closely.

* By making a series of tiny incision in the eye. One concern is whether the long-term effect of radial keratotomy might be loss of vision.

5. *Diffusion and Adoption*

Perhaps the most crucial decision in the entire innovation-development process is the decision to begin diffusing the innovation to potential adopters. On the one hand, there is usually pressure to approve an innovation for diffusion as soon as possible, as the social problem/need that it seeks to solve may have been given a high priority. Public funds may have been used to sponsor the research and such financial support is an unrealized public investment until the innovation is adopted by users. On the other hand, the change agency's reputation and credibility in the eyes of its clients rests on only recommending innovations that will have beneficial consequences for their adopters. Scientists tend to be cautious when it comes time to translate their scientific findings into practice. »

TECHNOLOGY GATEKEEPING

Innovation gatekeeping intended to determine which innovations should be diffused is performed in a variety of ways by different organizations. Agricultural experiment stations in each of the fifty states develop farm innovations and then turn them over to their state agricultural extension services to diffuse; each innovation that is judged ready for diffusion is recommended to farmers for their adoption by agricultural experts. The innovation may be given a blanket approval, or it may just be recommended for certain farmers, for certain climatic or soil conditions, or for other special conditions. We see in the case of agriculture that an organizational interface is involved at the point of the decision to begin diffusing an innovation, as the new technology passes from R&D workers (in agricultural experiment stations) to a diffusion agency (the agricultural extension service). A similar organizational interface between R&D and a diffusion agency is also involved in many other fields.

There is a strong concern in medical diffusion with exerting "quality control" over the technologies that diffuse to practitioners, so that (1) the only innovations that spread have desirable consequences, (2) certain innovations do not diffuse too rapidly, and (3) some innovations, once adopted, are not overused. This concern with regulating the diffusion of medical technologies is understandable, given the possible threat to human life that may be involved. A novel

approach to gatekeeping medical innovations is followed by the National Institutes of Health through the conduct of "consensus development conferences." *Consensus development* is a process that brings together biomedical research scientists, practicing physicians, consumers, and others in an effort to reach general agreement on whether a given medical technology is safe and effective (Lowe, 1980). The technology may be a device, a drug, or a medical or surgical procedure. A consensus conference differs from the usual state-of-the-art scientific meeting in that a broadly based panel is constituted to address a set of predetermined questions regarding the particular medical innovation under review. A three-day consensus conference typically begins with a series of research synthesis papers that are discussed by the expert investigators, users of the technology, and their consumers. A consensus statement is prepared by the panel and read on the final day of the conference to the audience who then react to it. The final consensus statement is then published by the U.S. Government Printing Office and widely disseminated to physicians, the mass media, medical journals, and the public.

Consensus conferences were begun in 1978 in recognition of the fact that the medical field lacked a formal process to assure that medical research discoveries were identified and scientifically evaluated to determine if they were ready to be used by doctors and other health-care workers. It was feared that some new technologies might have been disseminated without an adequate scientific test, while other well-validated medical technologies might be diffusing too slowly. The consensus panels have, in fact, occasionally recommended against using a given medical or surgical procedure, device, or drug under certain conditions. So they serve an important function in gatekeeping the flow of medical innovations from research into practice.

A similar function to the consensus development conference is performed by other mechanisms in certain other federal mission agencies. For instance, the National Diffusion Network (NDN) of the U.S. Department of Education uses a standing committee (called the Joint Dissemination Review Panel) as a scientific jury to decide which new educational innovations shall be diffused after these new teaching and learning ideas have been developed by local school personnel (Chapter 8). But in most change agencies the crucial decision as to which innovations to diffuse to users is made less formally and hence responsibility for this choice may be rather loose. "

CLINICAL TRIALS

Innovations may be approved or disapproved for diffusion to users on the basis of their evaluation in clinical trials that may have been conducted at the commercialization phase of the innovation-development process. *Clinical trials* are scientific experiments designed to determine prospectively the effects of an innovation in terms of its efficacy, safety, and other factors. In the field of medicine, clinical trials cost on the average about $1,000 to $2,000 per patient per year. If a new drug is administered in clinical trials to 100 patients, the total budget would thus be $100,000 to $200,000. Clinical trials for cardiovascular disease therapies often involve thousands of patients and hundreds of medical investigators and cost as much as $100 million (Finkelstein et al, 1981). In the case of medicine, where a very precise scientific evaluation of technological innovation is important, the high cost of clinical trials may be justified.

The purpose of clinical trials is to evaluate the effects of an innovation under real-life conditions, as a basis for making a go/no-go decision as to the diffusion of the innovation.

THE DECISION TO DIFFUSE AN INNOVATION

It would be highly oversimplistic to picture the innovation-development process as consisting of new technologies that emerge from research, and then spread to users and practitioners where they are adopted and used in an invariant form. A more realistic picture is provided by Braun and MacDonald (1978, p. 1): "A technological innovation is like a river—its growth and development depending on its tributaries and on the conditions it encounters on its way." Reinvention represents changes in an innovation that are made by its adopters in order to fit the technology to their specific conditions. The cost, size, functioning, and other characteristics of a particular innovation frequently" are determined by R&D workers in light of the needs/problems of potential adopters. So the reality of the innovation-development process suggests that the distinction between the R&D phase versus the diffusion/adoption phase may not be as clear-cut as our present discussion might imply, even though these two phases are heuristically distinct.

A very crucial point in the innovation-development process is the decision to begin diffusing the innovation to potential adopters. Here

is where the research/development/commercialization systems must relate to the diffusion agencies that will communicate the innovation to its users. Researchers and diffusers may not share a common perspective of the innovation, and conflict is sometimes involved in the decision about whether to begin diffusing a new idea. For example, observers of the research/extension interface in agriculture report that sometimes a time lag occurs before the dissemination of a technological innovation by the agricultural extension service begins, after research and development of the technology is completed. In other cases, diffusion of a new technology may begin even before agricultural researchers consider that sufficient scientific evidence has been gathered for the innovation to be recommended for adoption. This diffusion before research may prove to be problematic in some cases.

Another problem of organizational relationships can occur in the innovation-development process when one state's agricultural research and extension organization recommends an innovation, while the parallel organization in another state does not recommend the same innovation. Farm magazines and other mass media channels inform farm audiences in both states about this inconsistency in the state policies regarding the innovation. An example of this coordination problem was reported by Consumer Dynamics, Inc. (1980) for the innovation of no-till farming in Washington County, Iowa. This technology cluster consists of a one-pass tillage and planting operation that leaves crop residues on the soil surface; it eliminates the use of a molboard plow.*

No-till farming was researched in the 1950s, and it began to diffuse in Virginia and Kentucky in the 1960s. Researchers at the Iowa Agricultural Experiment Station and extension specialists at the Iowa Extension Service, however, opposed no-till farming for many years. They felt that a modification of no-till farming called minimum tillage (in which the ground is worked somewhat) was more appropriate for Iowa conditions. By 1970, some Iowa farmers heard about no-till farming from their contacts with farmers in other states, and from articles in farm magazines. In 1976, some Washington County farmers became interested in this innovation, and the first adoptions occurred in 1977. The John Deere Implement Company dealer in Washington

* *No-till farming* is defined as planting seed (usually corn or soybeans) into untilled soil by opening a narrow slot or trench of sufficient depth for seed coverage and soil contact, and using herbicides to control weeds and unwanted plants, thus eliminating such conventional methods of seed-bed preparation and cultivation as plowing, disking, harrowing, cultivating, and so on.

County began to sell no-till planters, and a local chemical dealer began to sell the weedicide that is used to kill existing vegetation, in place of plowing.

Finally, in 1978, the county extension agent in Washington County began holding farmer meetings to diffuse this innovation, and three or four more adoptions occurred in 1978-1979. The savings in tractor fuel and in farm labor, plus the increased soil conservation provided by no-till farming, quickly convinced many Washington County farmers to adopt this innovation cluster, and about fifty farmers adopted in 1980. Thus, the s-curve of diffusion got under way.

What implications about organizational linkages in the innovation development process are suggested by the Consumer Dynamics, Inc. (1980) study of no-till farming in Washington County, Iowa?

1. The research/extension support for an innovation cluster, or lack of it, can speed up or retard the rate of adoption of the cluster in a state or in a county. Iowa Tanners are about fifteen years behind those in Kentucky, Virginia, Maryland, and Tennessee in their adoption of no-till farming, largely because Iowa State University was relatively late in recommending the innovation.

2. Commercial vendors of the purchased products/equipment can affect the rate of adoption of a technology cluster on the basis of when (and if) they make available the inputs necessary for adoption. For example, the very early adopters of no-till farming in the 1960s initially could not purchase no-till planters (the Allis-Chalmers Company manufactured the first commercial machine in 1967), so they had to improvise in making their own no-till planters with the help of a home welder.* And paraquat weed spray, an essential element in the no-till technology cluster, did not become widely available until about 1968. When these two commercial products became easily available for purchase in western Kentucky, the rate of adoption of no-till farming took off rapidly (Choi and Coughenour, 1979).

Perhaps this case of no-till farming helps indicate the importance of interorganizational relationships in the innovation-development process. The linkages between the research and development versus the diffusion phases, between one state's diffusion system and another state's, and public organizations and private firms, were all involved in determining farmers' use of no-till farming in Iowa and

* Harry Young, a farmer in Christian County, Kentucky, played an important role in the history of no-till farming when he helped the Allis-Chalmers Company realize that they had actually designed the first commercially manufactured no-till planter in 1962, although this machine had been intended for a different use.

Kentucky and, thus, in the important consequences of this technology cluster (Consumer Dynamics, Inc., 1980; Choi, 1979; Choi and Coughenour, 1979).

6. *Consequences*

The final phase in the innovation-development process is the consequences of an innovation. Here the original problem/need that began the entire process either is or is not solved by the innovation. Often new problems/needs may be caused by the innovation so another cycle of the innovation development process is set off. Further detail on the consequences of an innovation is presented in Chapter 11.

We have implied in the present section that the six phases in the innovation-development process occur in the linear sequence in which they were discussed. On the contrary, in many cases certain of these phases do not occur, or the time-order of the phases may be changed.

The Natural History of an Innovation: Warfarin*

The story of warfarin, the most widely used rat poison in the world today, helps illustrate how scientific research aimed at solving one problem led to a technological innovation that is tremendously effective at solving a different problem. Research by Dr. K. P. Link and his associates at the University of Wisconsin in 1934 was designed to find the chemical agent in spoiled sweet clover that led cattle to hemorrhage. Many Midwestern farmers fed their cattle sweet clover hay in those days, in part because sweet clover was recommended by experts as a crop with the ability to "sweeten" an acidic soil. As an extra bonus, sweet clover had the desirable ability to minimize soil erosion.

But when sweet clover hay was fed to cattle, they sometimes became ill and, unless treated, died from internal hemorrhaging. Farmers called this mysterious illness "sweet clover disease."

Professor Link and his co-researchers at Madison set out to isolate the hemorrhagic agent in spoiled sweet clover. They found the anticoagulent to be coumarin, and biomedical researchers soon began to test the usefulness of this agent in certain types of surgery and on some heart conditions. But the most important application of Dr. Link's findings from his research on sweet clover disease did not occur until a dozen years later, when Link began to experiment in 1945 with using coumarin and its derivatives as a rodenticide.

* This case illustration is based somewhat on Lowe (1981).

Dr. Link applied to the Wisconsin Alumni Research Foundation (WARF), the University of Wisconsin's R&D "kitty," for funds to pursue his research on coumarin as a rat killer. A derivative of coumarin was found to be a highly effective rat poison. In 1948, this chemical derivative, now called "warfarin" (after WARF), was released to commercial manufacturers with the royalties going back to WARF. These returns from warfarin have given a tremendous boost to scientists at the University of Wisconsin; today the profits from warfarin fund many of the Madison professors' pet research projects, research assistantships for doctoral students, and other research expenses.

Today, over 400 different companies market rat killers containing warfarin, usually in only very minute amounts; the most common products that are sold only contain 0.025 percent warfarin with the rest of the product consisting of grain or other bait that rats like to eat. But warfarin poison is highly lethal to rats. One quality of warfarin's rat-killing ability was especially important in its diffusion. Because warfarin kills rats by causing internal bleeding, the stricken rodents seek water and thus do not usually die in their burrows. So farmers and homeowners can readily observe the effectiveness of warfarin in eradicating rats; the observability of the innovation is thus enhanced by its biochemical nature. And warfarin is not dangerous to dogs, cats, or humans who may happen to consume it.

Today, over 3.5 tons of warfarin are sold each year, with about half of this rat poison being used by farmers. Total retail sales of warfarin-based rodenticides are about $50 to 100 million per year. Overall savings from warfarin in the form of avoiding grain loss and property damage are undoubtedly many times this $50-100-million figure. But the exact benefits to society derived from warfarin are difficult to estimate.

Today, it is easy to forget that Professor Link began the research that eventually led to the rat killer warfarin as an exploration of "sweet clover disease." The innovation-development process is highly uncertain and unpredictable, with serendipity and accident playing a major role. So our present model of the six-phased process of innovation development should be considered only a general guide from which most innovations in reality deviate.

Hard Tomatoes in California*

The nature of an innovation's diffusion and its consequences are often determined in part during the R&D work to create the innovation. We see an illustration of how diffusion is predetermined by decisions and events that occurred prior to the first adoption, in the case of the mechanized tomato harvester in California.

*This case illustration is based upon Rasmussen (1968), Schmitz and Seckler (1970), Hightower (1975), Friedland et al (1981), Fiske (1980), and especially, Friedland and Barton (1975).

California is the number-one agricultural state in America, and tomatoes are one of California's most important farm products. And much of U.S. tomato production is concentrated in California. Prior to the introduction of the mechanized harvester in 1962 about 4,000 farmers produced tomatoes in California; nine years later, only 600 of these growers were still in business. One effect of the new machine was, thus, to reduce the number of tomato farmers to about one-sixth of what it had been. In 1962, about 50,000 farmworkers, most of them immigrant Mexican men, were employed as tomato pickers in California. They were replaced by 1,152 machines (each costing about $65,000), plus about 18,000 workers who rode the harvesters to sort the damaged and immature tomatoes. About 80 percent of these sorters were women; only a few were Mexican Americans.

There were many other consequences of the mechanized harvesters. Tomato growing moved out of California's San Joaquin County into Yolo and Fresno Counties, where the soil and weather conditions were more ideally suited to mechanized farming. And the tomatoes changed too. To enable machine picking, agricultural scientists bred hard tomatoes that would not bruise so easily. Unfortunately, American consumers prefer soft tomatoes. Even though the hard tomatoes tasted the same, they contained somewhat fewer vitamins. But the housewives who purchased tomatoes gained one important advantage: the mechanized tomatoes were cheaper in price than they would otherwise have been.

So the development of the mechanized tomato picker had many and far-reaching consequences. Were these effects anticipated by the R&D workers who developed the mechanized pickers at the University of California at Davis? Not at all, say analysts of this case, such as Friedland and Barton (1975, p. 28), who conclude that these agricultural scientists were "social sleepwalkers." The creators of the mechanical harvesters were motivated to save the tomato industry for California when it was threatened by the termination of the Mexican *bracero* program in 1964 (which meant the end of cheap labor). The scientists showed little concern for how the social consequences of this new technology would adversely affect human lives, leading Hightower (1972) to title his book, *Hard Tomatoes, Hard Times.*

Almost all of the research to develop this technology was conducted by agricultural professors at the University of California at Davis, using over one million dollars of public funds (Schmitz and Seckler, 1970). The chief researcher was G. C. "Jack" Hanna, a specialist in vegetable crops. He took the lead in breeding a hard-tomato variety that could be machine harvested, despite the vigorous opposition of his colleagues and administrators who believed that his idea of mechanical picking was ridiculous. In fact, they feared that his bizarre project would damage the reputation of their department and of the University of California. But Hanna was so certain that his

approach was correct that in 1947, he went on leave for six weeks to visit New York in his search for hard-tomato varieties. He returned with some seeds of the "Red Top" variety, a tomato that was almost as hard as an apple when it was ripe. Hanna began to adapt this New York tomato to California conditions.

Finally, Hanna teamed with an agricultural engineer at Davis named Coby Lorenzen in a systems approach to mechanizing tomato harvesting. Lorenzen worked to design a machine that would cut off the tomato plant at soil level, pluck the fruits from the Vine, and elevate them past a crew of female tomato-sorters into a gondola truck for transportation to market. In 1971, Hanna developed a tomato variety, VF-145, that was ideal for machine picking. It was firm enough for machine harvesting, the fruits were easily detachable from the vein, and most of the tomatoes ripened at about the same time.

The other key element in the new technology cluster was the harvester, designed by Lorenzen, and produced by Hanna's friend, Ernest Blackwelder, a farm machinery manufacturer who contracted with the University of California.* Twenty-five machines were produced in that year. They had many technical problems at first: eighteen broke down immediately, and, of the seven remaining machines, only one completed the harvest season successfully. But the mechanical harvesters cut labor in half. In 1962, the twenty-five machines were improved, and harvested 1 percent of the crop. By 1963, there were sixty-six machines in use, and they picked about 3 percent of all the tomatoes.

The big boost occurred in 1964, when 224 tomato-picking machines brought in 25 percent of all tomatoes grown. This sudden increase in adoption occurred because the U.S. Congress ended the *bracero* program through which Mexican workers were brought to California. Professors Hanna and Lorenzen had foreseen this possibility, and that is one reason why they had rushed to develop the mechanized harvester. The tomato industry honored Hanna as the individual who "saved the tomato for California." Six years later, 1,521 of the machines harvested 99.9 percent of the tomato crop. And 32,000 former hand pickers were out of work.

In retrospect, one might wonder how differently the diffusion and adoption of this innovation might have been had the R&D workers designed a smaller machine, one that more of the 4,000 tomato farmers (as of 1962) could have adopted. What if the impending threat of a severe labor shortage in 1964 had not forced Hanna, Lorenzen, and Blackwelder to rush their prototype machine into production? What if the University of California at Davis had conducted social and economic research on the impact of farm mechanization prior to 1962, so that the destructive consequences of the new technology on employment and on tomato consumers might have been anticipated, and perhaps mitigated?

These issues are discussed later in Chapter 11, in a discussion of the consequences of technological innovation. Our main point here is that the decisions and activities occurring in the R&D phase of the technology development process directly affect the later diffusion phase. Diffusion scholars have in the past ignored this fact too long.

* By 1969, Blackwelder paid $225,000 in royalties to the University of California for the right to produce the tomato harvester (Schmitz and Seckler, 1970).

Socioeconomic Status, Equality, and Innovation Development

One of the important policy shifts in international development and on the part of the federal government during the 1970s was to pay much greater attention to issues of socioeconomic equality. These policy issues are directly related with every phase of the innovation-development process.

For example, a consistent finding from past researches on the diffusion phase is that individuals' socioeconomic status is highly related to their degree of change agent contact, and that status (and change agent contact) are in turn highly related to their degree of innovativeness (Chapter 9). Thus, some observers claim that change agencies cause increased inequality among their audience through the introduction of innovation clusters.

Further, the socioeconomic status of individual adopters is interfaced with the nature of the innovation at the research and development phases of the innovation-development process. For example, whether a new agricultural machine is produced as a four-row, a six-row, or as an eight-row model has an important influence on whether larger or smaller farmers will purchase it. In fact, whether research topics likely to benefit larger or smaller farmers are investigated by public R&D workers has much to say about who will eventually adopt the results of such research (Hightower, 1973).

Several illustrations of the interrelationships of socioeconomic status and various aspects of the innovation-development process can be suggested from studies in agriculture. One example is an evaluation of the impact of the "Green Thumb" project among Kentucky farmers (Case et al, 1982). Green Thumb is a computer-based information system that delivers frames of weather, market, and other information on request to a farmer on his home TV set. The Green

Thumb boxes were provided by the U.S. Department of Agriculture to 200 small-, medium-, and large-sized farmers at no cost for fifteen months in 1980-1981. So socioeconomic factors did not influence access or *adoption* of this technology cluster. But the degree of *use* of the Green Thumb system by a farmer was somewhat related to socioeconomic status; larger farmers value information as a factor in farming success more highly, they depend on such information as an important ingredient in their decision making, and they are willing to devote time and effort to information acquisition. The Green Thumb evaluation shows that even when a special effort is made to eliminate socioeconomic status as a factor in the adoption of a technology cluster, status variables still may impact on the consequences of the technology cluster.

A further example is also provided by the diffusion of home computers among farmers in Shelby and Todd Counties in Kentucky. Three or four farmers in each county were already using such personal computers when the present author conducted a survey there in 1981, and another ten to fifteen farmers in each county expected to adopt a home computer within the next year. All of the current and expected adopters were very large and well-educated farmers; this socioeconomic relationship with adoption of home computers is partly due (1) to the relatively high cost (typically about $4,000) of a home computer, and (2) to the fact that few software programs appropriate for farm-business analysis were available, so they had to be formulated by each farmer for his own purposes, and only the better-educated farmers were able to use computer-programming languages to write their programs. Perhaps this situation will change as computer prices decline, or as agricultural extension services launch educational programs about computer use, so that less elite farmers can also learn about computer use.

Yet another example of status relationships with an innovation cluster is demonstrated by no-till farming. This technology cluster is not inherently farm-size-dependent, although surveys (for example, Choi, 1979) show that farmers adopting no-till farming (compared with nonadopters) are elites. This connection of socioeconomic status with the adoption of no-till farming may be due (1) to the cost of equipment (about $9,000 to $10,000 for a six-row planter; while two-row no-till planters are manufactured by several companies, they are not available at local dealers), and (2) to the fact that higher-status farmers with larger-sized operations find the labor-saving and energy-conserving aspects of no-till farming especially advantageous. But there is no inherent reason why the no-till technology cluster could not have been equally appropriate for smaller farmers.

Could these technology clusters (such as the Green Thumb system, home computers for farm-business analysis, and no-till farming) have been developed and diffused in a way that would have led to greater equality in their socioeconomic consequences? The answer lies in a more thorough analysis of how socioeconomic status factors affect each step in the innovation-development process, including the consequences of this process. And this need for future research on social status in consequences should not be limited to agriculture.

Tracing the Innovation-Development Process

There is a long background of research on tracing the research, development, and commercialization phases of the innovation-development process (as we showed in Figure 4-1). These retrospective tracer studies try to reconstruct the sequence of main events and decisions in the innovation-development process. The sources of data are usually personal interviews with key investigators and other participants, research publications, and archival records of research grants, patents, and change agency records.

One of the first, and best-known, retrospective tracer studies of the research and development phases of the innovation-development process is Project Hindsight (Isenson, 1969). This massive tracer study investigated the role of various R&D variables in the research and development activities leading to twenty different military weapons systems, such as the Minuteman missile, the Polaris submarine, the C-141 transport aircraft, and the M-61 nuclear warhead. The major events and decisions in the process of creating each of the twenty technological innovations were identified, an average of about thirty-five events per innovation. Project Hindsight concluded that most of the research that contributed to creation of the twenty innovations was highly applied, and was funded in order to produce the particular weapons system that eventually resulted. The findings of Project Hindsight are usually interpreted to mean that applied research contributes more directly to creation of a technological innovation than does basic research—hardly a surprising conclusion.

The most significant result of Project Hindsight, however, may be that it led to further innovation tracer studies, first by the Illinois Institute of Technology Research Institute (1968) in Project TRACES (Technology in Retrospect and Critical Events in Science), and later by the Battelle-Columbus Laboratories in what was termed TRACES II (Globe et al, 1973) and TRACES III (Battelle-Columbus Laboratories, 1976). These investigations, along with Project Sappho in England (Achilladelis et al, 1971), represent further improvements in the methodology of retrospective tracer studies, and a broadening of the technological studies from military weapons to a variety of biomedical, agricultural, consumer, and other innovations.

These tracer studies generally show that a major technological advance in such fields as military weapons, medicine, or agriculture requires not just one innovation, but a cluster of innovations, often as many as a dozen. For example, the heart pacemaker was an innovation cluster that depended upon the prior invention of electronic transistors, compact batteries, and other developments (Globe et al, 1973).

Further, the innovation tracer studies show that a lengthy period, often about twenty years, occurs between an invention in basic research, and its application in a weaponry or medical innovation. It seems that the basic research results have to "age" before they can be packaged into a useful innovation. For example, the length of time from first conception of a technological innovation to its first *realization* was nine years (from 1951 to 1960) for oral contraceptives (Globe et al, 1973). The comparable period for two agricultural innovations was much longer: twenty-five years for hybrid corn (1908 to 1933), and thirteen years for insecticides (1934 to 1947). The ten innovations studied in the TRACES II study required an average of nineteen years from first conception to first realization (Globe et al, 1973).

Finally, the tracer studies show that research is often conducted without a practical application to a social problem in mind. This point is made by Comroe (1977), who traced the innovation-development process for the ten most important technologies in cardiopulmonary medicine. Of the 500 or so key research articles leading to these innovations, 41 percent reported research that, at the time it was conducted, had no relationship whatever to the disease that it helped treat. This widely quoted finding implies that the innovation-development process does not always begin with a perceived problem or need.

Shortcomings of the Tracer Studies

There are several weaknesses in the innovation tracer studies that need to be improved in future research. For one, these studies are retrospective; much could also be learned from conducting prospective studies of the innovation-development process. Further, past tracer studies focused upon very important technological innovations like the heart pacemaker, oral contraceptives, and the Minuteman missile. We do not know if similar results would obtain for less significant innovations.

Further, the data sources for these tracer studies are rather limited:

1. These tracer studies depended almost entirely upon the availability of research publications about the technology, in order to reconstruct a partial view of the R&D phases of the innovation-development process.
2. In light of these limited data sources, the tracer studies generally describe the research and development phases of the process but do not tell much about the diffusion/adoption phase, and almost nothing about the consequences of the innovation.
3. Also because of the nature of the data sources, the tracer studies give the impression that the research and development phases are relatively rational and planned, the serendipitous and accidental aspects of invention and development may be less likely to be fully reported in research publications by the inventors and researchers.

Finally, as we showed in Figure 4-1, the tracer studies are too limited because they only deal with the research, development, and commercialization phases. Investigations of the *entire* innovation-development process are needed.

Questions for Future Research

At the beginning of this chapter we pointed out that our discussion of the innovation-development process is based on a rather thin research base. What research questions should be studied in the future?

1. How is the annual agenda of research priorities in a field set? How are users' needs and problems communicated to R&D workers?

What role does a change agency play in translating users' needs into R&D projects?

2. What is the impact on users' credibility in a change agency when it reverses its policy concerning an innovation, for example, by recommending the innovation's discontinuance?

3. To what extent are technological innovations developed by users, rather than by R&D experts?

4. What are the consequences of a technological innovation on socioeconomic equality, and how is this impact of an innovation affected by its form (such as its size and cost), which was determined at the development and commercialization phases?

5. What are the key linkages and interrelationships among the various organizations involved in the innovation development process? Particularly, how do researchers and change agents come together in making the decision to begin to diffuse an innovation?

Converting Research into Practice

There are often strong pressures from legislators on the federal administrators of research programs to show that the results of their research are being communicated to users and that these innovations are being adopted. A few years ago, one U.S. congressman became known for his grilling of Federal research directors in annual budget hearings. One might imagine an inquisition somewhat like the following:

CONGRESSMAN: Now Director, I have figures here showing that your agency spent $600 million for research last year.

RESEARCH DIRECTOR: Yes, Mr. Congressman, I believe that figure is correct.

CONGRESSMAN: Now can you tell us how this public investment in research has actually helped users' practice?

Often, there would be a long pause before the research director could respond. The chief of the U.S. Forest Service, which conducts a large program of federally sponsored research, was asked by U.S. congressmen at a 1971 budget hearing to identify the most widely adopted innovations to come out of research. For example, one of these innovations was chemical-fire retardant, which is dropped from planes to control forest fires. The congressmen then asked for an investigation of the actual rate of adoption by the U.S. Government Accounting Office (1972). The GAO found that innovations like chemical-fire retardant were widely used by foresters in one or two of the ten Forest Service regions, but not adopted at all in adjoining areas. This unequal rate of adoption made the GAO evaluators shake their heads. Their analysis of the ineffective diffusion of research-based innovations in the Forest Service suggested that the problem was due (1) to Forest Service researchers who were not oriented to the practical problems of forest rangers, nor were they rewarded for utilization of their research results, (2) to the fact that most practitioners (forest rangers) perceived of research as not having useful solutions to their practical problems, and (3) to the lack of an adequate diffusion system linking the research system with the practice system. Under pressure from the U.S. Congress, the Forest Service has experimented with various strategies to improve the effectiveness of the innovation development process in achieving more utilization of research-based technologies.

The Agricultural Extension Model

This experience of the U.S. Forest Service has had a strong effect on most other government research programs, who know that they will be held accountable for the adoption by practitioners of the innovations produced by federally funded research. By far the government agency that has been most successful in securing users' adoption of its research results is the agricultural extension services. Although this system is commonly called "the agricultural extension model," it actually consists of three main components: (1) a research subsystem, the fifty state agricultural experiment stations and the U.S. Department of Agriculture, which conduct agricultural research, (2) county extension agents, who work as change agents with farmers and other rural people at the local level, and (3) state extension specialists who link agricultural researchers to the county agents (Rogers et al, 1982). Both the researchers arid the extension specialists are located in state agricultural universities, and have similar levels of expertise (both are usually Ph.D.s in agriculture). So the agricultural extension model is actually an integrated system for the innovation-development process.

The agricultural extension services were established by the Smith-Lever Act of 1914, which stated that the purpose of this agency was: "To aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture and home economics, and to encourage the application of same." So the agricul-

tural extension service has a long history; in fact, it is probably the oldest diffusion system in the United States. Certainly, by reputation it is the most successful.

The budget for the extension services comes from federal, state, and county governments, and for this reason the term "Cooperative Extension Service" is often used for the entire system to indicate the collaboration of these three levels of government. The total annual budget for the agricultural extension services is presently around $600 million, an amount approximately equal to the annual public investment in agricultural research. This fifty-fifty level of funding for diffusion activities in agriculture is one reason for the success of the agricultural extension services; no other federal mission agency spends more than 4 or 5 percent of its research program on diffusion activities.

In fact, several other government agencies have tried to copy the agricultural extension model, but with only rather mixed success. Often the problem is that these attempts to extend the agricultural extension model have ignored one or more of the main elements in the model (Rogers et al, 1982). Some federal agencies install a diffusion system with the equivalent of extension specialists, but they fail to establish local-level change agents to contact clients directly (the counterpart to county extension agents). Other federal agencies forget that the agricultural extension services were established in 1914, and that it took over forty years for this change agency to cause the "agricultural revolution" in the 1950s and 1960s, in which the extension services diffused farming innovations so effectively that a tremendous increase in U.S. agricultural productivity resulted. Yet other extensions of the agricultural extension model overlooked the important fact that much agricultural research is geared toward farmers' problems; if this were not the case, most of the research results would be unusable. The attempts to copy the agricultural extension model in such fields as education, public transportation, social rehabilitation, energy, family planning, and others have therefore not been very successful to date.

Decentralized Diffusion Systems

One unfortunate effect of the great impact of the agricultural extension model, and of the fact that diffusion research began with the study of farming innovations, was to limit our thinking about the types of diffusion systems that might be possible. Much agricultural diffusion is relatively centralized, in that key decisions about which innovations to diffuse, how to diffuse them, and to whom, are made by a small number of technically expert officials near the top of a diffusion system.

A quite different type of diffusion, we now realize, is also possible, in which there is a wide sharing of power and control among the members of the diffusion system. Local users may invent and develop the innovations to solve their problems, and then diffuse these new ideas to other users via horizontal networks. Such decentralized diffusion systems are not run by a small set of technical experts, and formal R&D may play a minor role.

From the viewpoint of getting innovations put into practice, such decentralized systems have some obvious advantages. For one thing, heterophily on technical expertise does not exist as a barrier in the innovation-development process. The clients are their own change agents, for example. But such decentralized diffusion systems also come with certain disadvantages for particular situations, as we will show in Chapter 9. Thus, we feel that relatively centralized diffusion systems are most appropriate under certain conditions, and that more decentralized systems may best fit other circumstances. Or perhaps a combination of some elements of both centralized and decentralized diffusion are most appropriate.

Summary

Past diffusion researches all began with the first adopter of an innovation, that is, with the beginning of the left-hand tail of the S-shaped diffusion process. The events and decisions occurring previous to this point have a considerable influence upon the diffusion process, and in this chapter we have urged that the scope of future diffusion research should be broadened to include study of the entire process of how an innovation is generated.

The *innovation-development process* consists of all the decisions, activities, and their impacts that occur from recognition of a need or problem, through research, development, and commercialization of an innovation, through diffusion and adoption of the innovation by users, to its consequences. Recognition of a problem or need may happen by means of a political process through which a social problem

rises to a high priority on the agenda of problems that deserve research; in other cases, a scientist may perceive a future problem or sense a present difficulty and begin a research program to seek solutions.

Most, but not all, innovations come out of research. *Basic research* consists of original investigations for the advancement of scientific knowledge that do not have the specific objective of applying this knowledge to practical problems. The results of basic research are used in *applied research,* which consists of scientific investigations that are intended to solve practical problems.

The usual next phase in the innovation-development process is *development,* defined as the process of putting a new idea into a form that is expected to meet the needs of an audience of potential adopters. The next phase, *commercialization,* is defined as the production, manufacturing, packaging, marketing, and distribution of a product that embodies an innovation. Commercialization is usually done by private firms, as the name of this phase implies.

One of the most crucial points in the innovation-development process is the decision to begin diffusing an innovation to potential adopters; this choice point represents an arena in which researchers come together with change agents. *Clinical trials* are scientific experiments that are designed to determine prospectively the effects of an innovation in terms of its efficacy, safety, and the like.

Finally, the innovation diffuses, is adopted, and eventually causes consequences, the final step in the innovation-development process. The six phases described here may not always occur in a linear sequence, the time-order of the phases may be different, or certain phases may not occur at all.

CHAPTER 5

The Innovation-Decision Process

One must learn by doing the thing, for though you think you know it—you have no certainty, until you try.

(Sophocles, 400 B.C.)

THE INNOVATION-DECISION PROCESS is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision. This process consists of a series of actions and choices over time through which an individual or an organization evaluates a new idea and decides whether or not to incorporate the new idea into ongoing practice. This behavior consists essentially of dealing with the uncertainty that is inherently involved in deciding about a *new* alternative to those previously in existence. It is the perceived newness of the innovation, and the uncertainty associated with this newness, that is a distinctive aspect of innovation decision making (compared to other types of decision making).

The purpose of this chapter is to describe a model of the innovation-decision process, to propose five stages in this process, and to summarize evidence that these stages exist. Our main concern here is with optional innovation-decisions that are made by individuals, although much of what is said contributes a basis for our later discussion of the innovation-decision process in organizations (Chapter 10).

A Model of the Innovation-Decision Process

Diffusion scholars have long recognized that an individual's decision about an innovation is not an instantaneous act. Rather, it is *a process*

that occurs over time and consists of a series of actions. What is the exact nature of these sequential stages in the process of innovation decision making?

Our present model of the innovation-decision process is depicted in Figure 5-1. The present conceptualization consists of five stages:

1. *Knowledge* occurs when an individual (or other decision-making unit) is exposed to the innovation's existence and gains some understanding of how it functions.
2. *Persuasion* occurs when an individual (or other decision-making unit) forms a favorable or unfavorable attitude toward the innovation.
3. *Decision* occurs when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation.
4. *Implementation* occurs when an individual (or other decision-making unit) puts an innovation into use.
5. *Confirmation* occurs when an individual (or other decision-making unit) seeks reinforcement of an innovation-decision already made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation.

In the following pages we describe in greater detail behaviors that occur at each of the five stages in the innovation-decision process.

Knowledge Stage

We conceive of the innovation-decision process as beginning with the knowledge stage which commences when the individual (or other decision-making unit) is exposed to the innovation's existence and gains some understanding of how it functions.

Which Comes First, Needs or Awareness of an Innovation?

Some observers claim that an individual plays a passive role in being exposed to awareness-knowledge about an innovation. It is argued that one becomes aware of an innovation quite by accident, as one cannot actively seek an innovation until one knows that it exists. For example, Coleman et al (1966, p. 59) concluded that initial knowledge

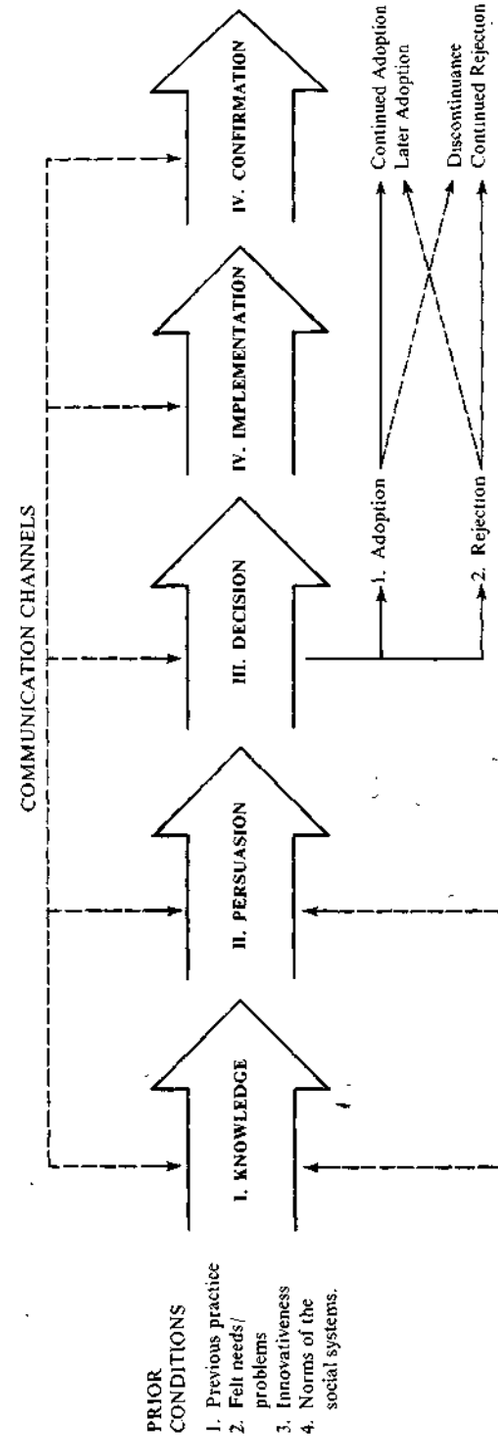

Figure 5-1. A model of stages in the innovation-decision process.

The *innovation-decision process* is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.

Note that for the sake of simplicity we have not shown the consequences of the innovation in this diagram.

about a new medical drug mainly occurred through communication channels and messages (such as salespersons and advertising) that physicians did not seek; at later stages in the innovation-decision process, however, doctors became active information seekers, usually from network peers.

Other scholars of diffusion feel that an individual gains awareness-knowledge only through behavior that must be initiated, and that awareness is not just a passive activity. The predispositions of individuals influence their behavior toward communication messages and the effects that such messages are likely to have. Individuals generally tend to expose themselves to ideas that are in accordance with their interests, needs, or existing attitudes. We consciously or unconsciously avoid messages that are in conflict with our predispositions. This tendency is called *selective exposure.* * Hassinger (1959) argues that individuals will seldom expose themselves to messages about an innovation unless they first feel a need for the innovation, and that even if such individuals are exposed to these innovation messages, such exposure will have little effect unless the individual perceives the innovation as relevant to his needs and as consistent with his existing attitudes and beliefs.* For example, a farmer can drive past one hundred miles of hybrid corn in Iowa and never "see" the innovation. A Californian can walk past a house with solar panels on the roof and not perceive this innovation. Selective exposure and selective perception act as particularly tight shutters on the windows of our minds in the case of innovation messages, because such ideas are new. We cannot have consistent and favorable attitudes and beliefs about ideas that we have not previously encountered. There is, then, much in the ideas of selective exposure and selective perception to support Hassinger's viewpoint that need for an innovation must usually precede awareness-knowledge of the innovation.

But how are needs created? A need is a state of dissatisfaction or frustration that occurs when one's desires outweigh one's actualities, when "wants" outrun "gets." An individual may develop a need when he or she learns that an innovation exists. Therefore, innovations *can* lead to needs as well as vice versa. Some change agents create needs among their clients through pointing out the existence of desirable new ideas. Thus knowledge of the existence of an innovation can create motivation for its adoption.

* *Selective exposure* is the tendency to attend to communication messages that are consistent with one's existing attitudes and beliefs.

*This is *selective perception,* the tendency to interpret communication messages in terms of one's existing attitudes and beliefs.

By no means are perceived needs or problems a very complete explanation of why individuals begin the innovation-decision process. In part, this is because individuals do not always recognize when they have a problem, nor do individuals' needs always agree with what experts might think the individuals need. Professor Edgar Dale was fond of saying:"We may want food but not need it. And we may need vitamins and minerals and fail to want them."

What can we conclude? Does a need precede knowledge of a new idea, or does knowledge of an innovation create a need for that new idea? Perhaps this is a chicken-or-egg problem. In any event, available research does not provide a clear answer to this question of whether awareness of a need or awareness of an innovation (that creates a need) comes first. The need for certain innovations, such as a pesticide to treat a new bug that is destroying a farmer's crops, probably comes first. But for many other new ideas the innovation may create the need. This sequence may be especially likely for consumer innovations like clothing fashions.

Types of Knowledge about an Innovation

As we stated in Chapter 1, the innovation-decision process is essentially an information-seeking and information-processing activity in which the individual is motivated to reduce uncertainty about the advantages and the disadvantages of the innovation. An innovation typically contains *software information,* which is embodied in the innovation and serves to reduce uncertainty about the cause-effect relationships that are involved in achieving a desired outcome (such as meeting a need or problem of the individual). Questions such as "What is the innovation?" "How does it work?" and "Why does it work?" are the main concerns of an individual, once he or she is aware that an innovation exists. So awareness-knowledge motivates an individual to seek "how-to" knowledge and principles knowledge. This type of information seeking is concentrated at the knowledge stage of the innovation-decision process, but it may also occur at the persuasion and decision stages.

How-to knowledge consists of information necessary to use an innovation properly. The adopter must understand what quantity of an innovation to secure, how to use it correctly, and so on. In the case of innovations that are relatively more complex, the amount of how-to knowledge needed for proper adoption is much greater than in the case of less complex ideas. And when an adequate level of how-to

knowledge is not obtained prior to the trial and adoption of an innovation, rejection or discontinuance is likely to result. To date, we have few diffusion investigations that deal with how-to knowledge.*

Principles knowledge consists of information dealing with the functioning principles underlying how the innovation works. Examples of principles knowledge are: the notion of germ theory, which underlies the functioning of vaccinations and latrines in village sanitation and health campaigns; the fundamentals of human reproduction, which form a basis for family-planning innovations; and the biology of plant growth, which underlies fertilizer innovations. It is usually possible to adopt an innovation without principles knowledge, but the danger of misusing the new idea is greater, and discontinuance may result. Certainly, the long-range competence of individuals to judge future innovations is facilitated by principles know-how.

What is the role of change agents in bringing about the three types of knowledge? Most change agents seem to concentrate their efforts on creating awareness-knowledge, although this goal often can be achieved more efficiently in many client systems by mass media channels. Change agents could perhaps play their most distinctive and important role in the innovation-decision process if they concentrated on how-to knowledge, which is probably most essential to clients at the trial and decision stage in the process. Most change agents perceive that creation of principles knowledge is outside the purview of their responsibilities and is a more appropriate task for formal schooling and general education. It is admittedly difficult for change agents to teach basic understanding of principles. But when such understanding is lacking, the change agent's long-run task remains very difficult.

Early Versus Late Knowers of Innovations

The following generalizations summarize the results of findings regarding early knowing about an innovation:

Generalization 5-1: *Earlier knowers of an innovation have more education than later knowers.*

Generalization 5-2: *Earlier knowers of an innovation have higher social status than later knowers.*

* Among the few inquiries of this type are Keith (1968), who determined the variables correlated with knowledge of 14 agricultural innovations among 1,347 Nigerian peasants, White (1968), who studied the correlates of knowledge of innovations among Canadian farmers, and Shingi and Mody (1976), who studied the impact of television in changing Indian farmers' knowledge of agricultural innovations. Their findings (and those of other researchers) about the characteristics of early and late knowers about innovations are summarized later in this chapter.

Generalization 5-3: *Earlier knowers of an innovation have more exposure to mass media channels of communication than later knowers.*

Generalization 5-4: *Earlier knowers of an innovation have more exposure to interpersonal channels of communication than later knowers.*

Generalization 5-5: *Earlier knowers of an innovation have more change agent contact than later knowers.*

Generalization 5-6: *Earlier knowers of an innovation have more social participation than later knowers.*

Generalization 5-7: *Earlier knowers of an innovation are more cosmopolite than later knowers.*

The characteristics of earlier knowers of an innovation are similar to the characteristics of innovators: more education, higher social status, and the like. But of course this does not mean that earlier knowers are necessarily innovators.

Knowing about an innovation is often quite different from using the idea. Most individuals know about many innovations that they have not adopted. Why? One reason is because an individual may know about a new idea but not regard it as relevant to his situation, as potentially useful. Attitudes toward an innovation, therefore, frequently intervene between the knowledge and decision functions. In other words, the individual's attitudes or beliefs about the innovation have much to say about his passage through the innovation decision process. Consideration of a new idea does not pass beyond the knowledge function if an individual does not define the information as relevant to his or her situation or if sufficient knowledge is not obtained to become adequately informed so that persuasion can take place. What do we know about this persuasion stage?

Persuasion Stage

At the persuasion * stage in the innovation-decision process the individual forms a favorable or unfavorable attitude* toward the innova-

*We do not define persuasion with exactly the same connotation as certain other communication researchers, who use the term to imply a source's communication with an intent to induce attitude change in a desired direction on the part of a receiver. Our meaning for persuasion is equivalent to attitude formation and change on the part of an individual, but not necessarily in the direction intended by some particular source, such as a change agent. Our meaning of persuasion is oriented toward the receiver rather than toward the source.

* *Attitude* is a relatively enduring organization of an individual's beliefs about an object that predisposes his or her actions.

tion. Whereas the mental activity at the knowledge stage was mainly cognitive (or knowing), the main type of thinking at the persuasion function is affective (or feeling). Until the individual knows about a new idea, of course, he or she cannot begin to form an attitude toward it.

At the persuasion stage the individual becomes more psychologically involved with the innovation; he or she actively seeks information about the new idea. Here the important behaviors are *where* he or she seeks information, *what* messages he or she receives, and *how* he or she interprets the information that is received. Thus, selective perception is important in determining the individual's behavior at the persuasion stage, for it is at the persuasion stage that a general perception of the innovation is developed. Such perceived attributes of an innovation as its relative advantage, compatibility, and complexity are especially important at this stage (Figure 5-1).

In developing a favorable or unfavorable attitude toward the innovation, an individual may mentally apply the new idea to his or her present or anticipated future situation before deciding whether or not to try it. This is a kind of vicarious trial. The ability to think hypothetically and counter-factually and to project into the future is an important mental capacity at the persuasion stage where forward planning is involved.

All innovations carry some degree of uncertainty for the individual, who is typically unsure of the new idea's results and thus feels a need for social reinforcement of his or her attitudes toward the new idea. The individual wants to know that his or her thinking is on the right track in the opinion of his or her peers. Mass media messages are too general to provide the specific kind of reinforcement that the individual needs to confirm his or her beliefs about the innovation.

At the persuasion stage, and especially at the decision stage, an individual typically is motivated to seek *innovation-evaluation information,* which is the reduction in uncertainty about an innovation's expected consequences. Here an individual usually wants to know the answers to such questions as "What are the innovation's consequences?" and "What will its advantages and disadvantages be in my situation?" This type of information, while often easily available from scientific evaluations of an innovation, is usually sought by most individuals from their near-peers whose subjective opinion of the innovation (based on their personal experience with adoption of the new idea) is most convincing. When someone like ourselves tells us of their positive evaluation of a new idea, we are often motivated to adopt it.

The main outcome of the persuasion stage in the decision process is either a favorable or an unfavorable attitude toward the innovation. It is assumed that such persuasion will lead to a subsequent change in overt behavior (that is, adoption or rejection) consistent with the attitude held. But we know of many cases in which attitudes and actions are quite disparate.

Such a discrepancy between favorable attitudes and actual adoption is frequently found for contraceptive ideas in developing nations. For instance, surveys of parents of child-bearing age in nations like India and Pakistan show that 80 percent or more of these individuals say they are informed about family-planning methods and have a favorable attitude toward using them. But only 15 or 20 percent of the parents have actually adopted contraceptives (Rogers, 1973, p. 288). This attitude-use discrepancy is called the ''KAP-gap" (KAP refers to knowledge-attitude-practice) in the family planning field. Presumably this "gap" occurs because (1) contraceptives are not readily accessible, and/or (2) the available family planning methods are not very acceptable to parents owing to certain undesirable side effects that are associated with them in the minds of potential adopters.

Perhaps the important point here is that formation of a favorable or unfavorable attitude toward an innovation does not always lead directly or immediately to an adoption or rejection decision. Nevertheless, there is a tendency in this direction, that is, for attitudes and behavior to become more consistent.

A preventive innovation is a new idea that an individual adopts in order to avoid the possible occurrence of some unwanted event in the future. The undesired event may, or may not, occur if the innovation is not adopted. So the desired consequences of a preventive innovation are uncertain. Under such circumstances, the individual's motivation to adopt are rather weak. Examples of preventive innovations are contraceptives, the use of automobile seat belts, buying insurance, and making preparations for a possible disaster such as an earthquake or a hurricane. Even when an individual perceives a need for the innovation, and when it is accessible, adoption often does not occur. So the rate of adoption of preventive innovations is often quite slow.

The persuasion-adoption discrepancy for preventive innovations can sometimes be closed by a *cue-to-action,* an event occurring at a time that crystallizes a favorable attitude into overt behavior change. Some cues-to-action occur naturally; for instance, many women adopt contraception when they experience a pregnancy scare or an abortion (Rogers, 1973, pp. 295-296). In other cases, a cue-to-action

can sometimes be created by a change agency; for instance, some national family planning programs pay incentives in order to provide a cue-to-action to potential adopters.

Decision Stage

The *decision* stage in the innovation-decision process occurs when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation. *Adoption* is a decision to make full use of an innovation as the best course of action available. *Rejection* is a decision not to adopt an innovation.

For most individuals, one means of coping with the inherent uncertainty about an innovation's consequences is to try out the new idea on a partial basis. In fact, most individuals will not adopt an innovation without trying it first on a probationary basis to determine its usefulness in their own situation. This small-scale trial is often part of the decision to adopt, and is important as a means to decrease the perceived uncertainty of the innovation for the adopter. In some cases, an innovation cannot be divided for trial and so it must be adopted or rejected in toto. Innovations that can be divided for trial use are generally adopted more rapidly. Most individuals who try an innovation then move to an adoption decision, if the innovation has at least a certain degree of relative advantage. Methods to facilitate the trial of innovations such as the distribution to clients of free samples of a new idea, usually will speed up the rate of adoption. Evidence for this point is provided from a field experiment among Iowa farmers, where it was found that the free trial of a new weed spray speeded the innovation-decision period by about a year (Klonglan, 1962, 1963; Klonglan et al, 1960a, 1963).

For some individuals and for some innovations the trial of a new idea by a peer like themselves can substitute, at least in part, for their own trial of an innovation. This "trial by others" provides a kind of vicarious trial for an individual. Change agents often seek to speed up the innovation-process for individuals by sponsoring demonstrations of a new idea in a social system, and there is evidence that this demonstration strategy can be quite effective, especially if the demonstrator is an opinion leader (Magill and Rogers, 1981).

It is important to remember that the innovation-decision process can just as logically lead to a rejection decision as to adoption. In fact,

each stage in the process is a potential rejection point. For instance, it is possible to reject an innovation at the knowledge stage by simply forgetting about it after initial awareness. And, of course, rejection can occur even after a prior decision to adopt. This is discontinuance, which can occur in the confirmation function. Two different types of rejection can be distinguished (Eveland, 1979):

1. *Active rejection,* which consists of considering adoption of the innovation (including even its trial) but then deciding not to adopt it.
2. *Passive rejection* (also called nonadoption), which consists of never really considering use of the innovation.

Obviously, these two types of rejection represent quite different types of behavior. Unfortunately they have often not been distinguished in past diffusion researches. Perhaps owing to the pro-innovation bias that pervades much diffusion inquiry (Chapter 3), investigation of rejection behavior has not received much scientific attention.

Further, there is usually an implicit assumption in diffusion studies of a linear sequence of the first three stages in the innovation-decision process: knowledge-persuasion-decision. In some cases, the actual sequence of stages may be knowledge-decision-persuasion. For example, in a Korean village that I once studied, a meeting of married women was called, and, after a lecture by a government official about the IUD (intrauterine device) a show of hands was called for to indicate the women who wanted to adopt (Rogers and Kincaid, 1981, p. 15). Eighteen women volunteered, and promptly marched off to a nearby clinic to have lUDs inserted. In this case, a presumably optional innovation decision almost became a collective innovation-decision as a result of strong group pressure. A similar group-oriented strategy for family planning is followed in the "group planning of births" in the People's Republic of China and in the *banjar* approach of Bali, an Indonesian province (Rogers and Chen, 1980). In both places, the community decides who should have babies, and then parents are influenced to follow these group birth plans. Such strong group pressure for adoption of an innovation would be abhorrent to values on freedom in many cultures, but it is not in Korea, China, and Indonesia. So the knowledge-persuasion-decision sequence proposed in our model of the innovation-decision process (Figure 5-1) may be somewhat culture-bound. In some sociocultural settings, the knowl-

edge-decision-persuasion sequence may frequently occur, at least for certain innovations.

Implementation Stage

Implementation occurs when an individual (or other decision-making unit) puts an innovation into use. Until the implementation stage, the innovation-decision process has been a strictly mental exercise. But implementation involves overt behavior change, as the new idea is actually put into practice. Past conceptualizations of the innovation-decision process have generally not fully recognized the importance, or even the existence, of the implementation stage (for example, Rogers with Shoemaker, 1971, pp. 98-133). It is often one thing for the individual to decide to adopt a new idea, and quite a different thing to put the innovation into use. Problems in exactly how to use the innovation may crop up at the implementation stage. Implementation usually follows The decision stage rather directly unless it is held up by some logistical problem, like the temporary unavailability of the innovation.

A certain degree of uncertainty about the expected consequences of the innovation still exist for the individual at the implementation stage, even though the decision to adopt has been made previously. When it comes to implementation, an individual particularly wants to know the answers to such questions as "Where do I obtain the innovation?" "How do I use it?" and "What operational problems am I likely to encounter, and how can I solve them?" So active information seeking usually takes place at the implementation stage. Here the role of the change agent is mainly to provide technical assistance to the client as he or she begins to operate the innovation.

Problems of implementation are likely to be more serious when the adopter is an organization rather than an individual. In an organizational setting, a number of individuals are usually involved in the innovation-decision process, and the implementers are often a different set of people from the decision makers. Also, the organizational structure that gives stability and continuity to an organization, may be a resistant force to implementation of an innovation. As we show in Chapter 10, it was not until diffusion scholars began to study the innovation-decision process in organizations that the importance of the implementation stage was fully recognized. We still lack adequate studies of the implementation stage for individual/optional innovation decisions.

The End of Implementation

When does the implementation stage end? It may continue for a lengthy period of time, depending on the nature of the innovation. But eventually a point is reached at which the new idea becomes an institutionalized and regularized part of the adopter's ongoing operations. The innovation finally loses its distinctive quality as the separate identity of the new idea disappears. This point is usually considered the end of the implementation stage, and is often referred to as routinization or institutionalization.

It may also represent the termination of the innovation-decision process, at least for most individuals. But for others, a fifth stage of confirmation may occur, as we explain in a following section. But first we shall discuss the concept of re-invention, which is often one important part of the implementation stage.

Re-Invention

Until very recently we assumed that adoption of an innovation meant the exact copying or imitation of how the innovation had been used previously in a different setting. Sometimes the adoption of an innovation does indeed represent Identical behavior; for example, the California Fair Trade Law of 1931, the first law of its kind, was adopted by ten other states complete with three serious typographical errors that appeared in the California bill (Walker, 1971). In many other cases, however, an innovation is not invariant as it diffuses.

DEFINING RE-INVENTION

As we recounted in Chapter 1, diffusion scholars now recognize the concept of *re-invention,* defined as the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation. Until about the mid-1970s, re-invention was not thought to occur, or was considered at most a very infrequent behavior. When a respondent in a diffusion survey told about his or her re-

invention of a new idea, it was considered as a very unusual kind of behavior, and was treated as "noise" in diffusion research. Adopters were considered to be passive acceptors of innovations, rather than active modifiers and adapters of new ideas. Once diffusion scholars made the mental breakthrough of recognizing that re-invention could happen, they began to find that quite a lot of it occurred, at least for certain innovations. Naturally, re-invention could not really be investigated until diffusion researchers began to gather data about implementation, for most re-invention occurs at the implementation stage of the innovation-decision process. In fact, the recent finding that a great deal of re-invention occurs for certain innovations suggests that previous diffusion research, by measuring adoption as a stated intention to adopt (at the decision stage), may have erred by measuring innovation that did not actually occur in some cases, or at least that did not occur in the way that was expected. The fact that re-invention may occur is a strong argument for measuring adoption at the implementation stage, as change that has actually happened. As action by the adopter, rather than as intention.

Most scholars in the past have made a distinction between invention and innovation. *Invention* is the process by which a new idea is discovered or created, while *adoption* is a decision to make full use of an innovation as the best course of action available. Thus, adoption is the process of adopting an existing idea. This difference between invention and adoption, however, is not so clear-cut when we acknowledge that an innovation is not necessarily a fixed entity as it diffuses within a social system. For this reason, "re-invention" seems like a rather appropriate word to describe the degree to which an innovation is changed or modified by the user in the process of its adoption and implementation.*

How MUCH RE-INVENTION OCCURS?

The recent focus on re-invention was launched by Charters and Pellegrin (1972), who were the first scholars to recognize the occurrence of re-invention (although they did not use the term per se).

* At least re-invention is a more apt term than others proposed for this behavior, like the anthropological concept of *reinterpretation,* the process in which the adopters of an innovation use it in a different way and/or for different purposes than when it was invented or diffused to them. Although the idea of reinterpretation has been around for years, it has never caught on among diffusion scholars.

These researchers traced the adoption and implementation of the educational innovation of "differentiated staffing" in four schools over a one-year period. They concluded that "differentiated staffing was little more than a word for most participants [that is, teachers and school administrators], lacking concrete parameters with respect to the role performance of participants... .The word could (and did) mean widely differing things to the staff, and nothing to some.... The innovation was to be invented on the inside, not implemented from the outside." These scholars noted the degree to which the innovation was shaped differently in each of the four organizations they studied.*

When investigations are designed with the concept of re-invention in mind, a certain degree of re-invention is usually found. For instance, previous research on innovation in organizations had assumed that a new technological idea enters a system from external sources and then is adopted (with relatively little adaptation of the innovation) and implemented as part of the organization's ongoing operations. The assumption is that adoption of an innovation by individual or organization *A* will look much like adoption of this same innovation by individual or organization *B.* Recent investigations call this assumption into serious question. For instance:

- A national survey of schools adopting educational innovations promoted by the National Diffusion Network, a decentralized diffusion system, found that 56 percent of the adopters implemented only selected aspects of an innovation; much such re-invention was relatively minor, but 20 percent of the adoptions amounted to large changes in the innovation (Emrick et al, 1977, pp. 116-119).
- An investigation of 111 innovations in scientific instruments by von Hippel (1976) found that in about 80 percent of the cases, the innovation process was dominated by the user (that is, a customer). The user might even build a prototype model of the new product, and then turn it over to a manufacturer. So the "adopters" played a very important role in designing and redesigning these industrial innovations.
- Of the 104 adoptions of innovations by mental health agencies that were studied in California, re-invention occurred somewhat

* Undoubtedly one reason why Charters and Pellegrin became aware of re-invention was due (1) to their use of a process research approach rather than a variance research approach (as explained later in this chapter), and (2) to their focus on the implementation stage in the innovation-decision process for differentiated staffing.

more often (in 55 cases) than did unchanged adoption (in 49 cases) (Larsen and Agarwala-Rogers, 1977*a*, p. 37, 1977b).

- A study of the adoption by fifty-three local government agencies of a computer-based planning tool (called GBF/DIME) that was promoted to them by a federal agency, found that about half of the "adoptions" represented at least some degree of re-invention (Eveland et al, 1977; Rogers et al, 1977a).

On the basis of these investigations and a number of other recent studies of re-invention,* we suggest Generalization 5-8: *Re-invention occurs at the implementation stage for certain innovations and for certain adopters.*

RE-INVENTION Is NOT NECESSARILY BAD

Whether re-invention is good or bad depends on one's point of view. Re-invention generally does not receive much favorable attention from research and development agencies, who may consider re-invention a distortion of their original research product. In fact, some designers of innovation form it so that it is particularly difficult to re-invent; they may feel that "re-invention proofing" is a means of maintaining the quality control of their innovation. Diffusion agencies may also be unfavorable toward re-invention, feeling that they know best as to the form of the innovation that the users should adopt. Also, change agents often find it difficult to measure their performance if a specific innovation changes over time and across different adopters. Their usual measure, the rate of adoption of an innovation, can become an ambiguous index when a high degree of re-invention occurs.

Adopters, on the other hand, generally think that re-invention is good. They tend to emphasize or even overemphasize the amount of re-invention that they have accomplished (Rice and Rogers, 1980). The choices available to a potential adopter are not just adoption or rejection; modification of the innovation or selective rejection of some components of the innovation may also be options. Some implementation problems by an individual or an organization are unpredictable by nature, so changes in the originally planned innovation often should occur.

Re-invention can be beneficial to adapters of an innovation. Flexibility in the process of adopting an innovation may reduce mistakes and encourage customization of the innovation to fit it more appropriately to local and/or changing conditions. As a result of re-invention, an innovation may be more appropriate in matching the systems' preexisting problems and more responsive to new problems that arise during the innovation-decision process. Not surprisingly, a national survey of innovation in public schools found that when an educational innovation was re-invented by a school, its adoption was more likely to be continued and less likely to be discontinued (Berman and Pauley, 1975). Discontinuance happened less often because the re-invented innovations fit a school's circumstances better. This investigation disclosed that a rather high degree of re-invention occurred: the innovations and the schools engaged in a kind of mutually influencing interaction, as the new idea and the school adapted to each other (Berman and McLaughlin, 1974, 1975, 1978; Berman et al, 1975, 1977). Usually, the school changed very little, and the innovation substantially.*

Individuals and organizations come to the innovation-decision process for the same innovation with a wide variety of different needs, problems, and situations. These differences shape the actual innovation that is implemented, even though it may still be called by the same name as the "mainline" innovation. In fact, many of the elements in the mainline innovation may be adopted by an individual, while also departing from the original model in several important respects.**

*Including Agarwala-Rogers et al (1977); Berman and McLaughlin (1974, 1975, 1978); Berman et al (1975, 1977); Berman and Pauly (1975); Charters and Pellegrin (1972); Hall (1974); Hall and Loucks (1978); Rice and Rogers (1980); Rogers (1977); and Rogers et al (1975, 1979).

* Professor Yoshiyasu Uno and his colleagues, sociologists at Keio University in Tokyo, have developed the concept of intercultural refraction in a series of recent investigations and theoretic writings (Rogers, 1982). This research on refraction in Japan takes a somewhat similar point of view to that of scholars of re-invention in the United States, although the two sets of researchers developed their similar approaches while working independently. *Refraction* is the degree to which an innovation or the context of the innovation is changed when it is introduced into a new setting or situation. The term refraction comes from physics, where refraction in a beam of light occurs as it bends when passing from one substance into another, such as from air to water. The concept of refraction is a somewhat broader concept than re-invention as it includes changes in the innovation's context, as well as in the innovation itself.

** Eveland et al (1977) used one procedure for measuring re-invention: they identified the number of elements in each implementation of an innovation that were similar to, or different from, the "mainline" version of the innovation (that was promoted by a change agency). Whether such a measure of re-invention can be constructed for other innovations remains to be seen, but we believe that most innovations can be decomposed analytically into constituent elements, thus offering one means of indexing the degree of re-invention.

WHY DOES RE-INVENTION OCCUR?

Some of the reasons for re-invention are in the innovation itself, while others involve the individual or organization that is adopting the new idea.

1. Innovations that are relatively more complex and difficult to understand are more likely to be re-invented (Larsen and Agarwala-Rogers, 1977a, 1977b).

2. Re-invention can occur owing to the adapter's lack of detailed knowledge about the innovation, such as when there is relatively little direct contact between the adapter and change agents or previous adopters (Rogers et al, 1977a; Eveland et al, 1977; Larsen and Agarwala-Rogers, 1977a, p. 38). For example, re-invention of GBF/DIME occurred more frequently when change agents only created awareness-knowledge of the innovation, than when consultation was provided at the implementation stage. Re-invention, thus, sometimes happens owing to ignorance and to inadequate learning.

3. An innovation that is a general concept or that is a tool (like a computer) with many possible applications is more likely to be re-invented (Rogers, 1978). The elements comprising an innovation may be tightly or loosely bundled or packaged (Koontz, 1976). A tight-bundle innovation is a collection of highly interdependent components; it is difficult to adopt one element without adopting the other elements. A loose-bundle innovation consists of elements that are not highly interrelated; such an innovation can be flexibly suited by adapters to their conditions. So the designer or manufacturer of an innovation can affect the degree of re-invention by making the innovation easy or difficult to re-invent (von Hippel and Finkelstein, 1979).

4. When an innovation is implemented in order to solve a wide range of users' problems, re-invention is more likely to occur. A basic reason for re-invention is that one individual or organization matches the innovation with a different problem from another. The problem that originally motivates search for an innovation determines in part how the innovation will be used. We expect that the degree of re-invention for an innovation is likely to be greater when there is a wide degree of heterogeneity in the individual and organizational problems with which the innovation is matched.

5. Local pride of ownership of an innovation may also be a cause of re-invention. Here the innovation is modified in certain, perhaps rather cosmetic, minor ways so that it appears to be a local product. In some cases of such pseudo-re-invention, the innovation may just be given a new name, without any more fundamental changes in the innovation. Such localization may be motivated by a desire for status on the part of the adapter, or by a desire to make the innovation more acceptable to the local system. Often, when they are asked, "locals say that innovation is local," as Havelock (1974) found in a survey of 353 U.S. school superintendents. Perhaps as Professor Nathan Caplan at the University of Michigan has suggested, innovations may be somewhat like a toothbrush in that people do not like to borrow them from one another. They want their own. Or at least they want to put their own "bells and whistles" on the basic innovation, so that it looks different from others` adoptions of the innovation. There appears to be a strong psychological need to re-invent.

An illustration is provided by the diffusion of computers to local governments in the United States. During the 1970s there was a tremendous expansion in the use of computers for data processing by local city and county governments. These organizations soon were spending more than $1 billion per year for computer equipment and for computer software programs to perform such data-handling tasks as accounting, payrolls, and record keeping. An investigation by Danziger (1977) of how twelve cities and counties adopted the innovation of computer data processing found a surprisingly high rate of re-invention. One of the reasons for such re-invention is that computer programmers working in a local government viewed such modification of packaged innovations as a challenging and creative task. It was more fun to re-invent a computer program than simply to transfer it from another local government or to purchase it from a commercial supplier, which was viewed as unstimulating and filled with drudgery. Further, Danziger (1977) found that local government officials emphasized the degree of re-invention that they had performed with each of them stressing the uniqueness of their adoption. This pride in their re-invention is an example of what Freud called "the narcissism of small differences." The relatively petty bells and whistles that the adapters had re-invented appeared to them to be major improvements.

6. Finally, re-invention may occur because a change agency influences its clients to modify or adapt an innovation. As we discussed previously, change agencies generally oppose re-invention. Decentralized diffusion systems (Chapter 9), however, may encourage their clients to re-invent new ideas.

Recognition of the existence of re-invention brings into focus a

different view of adoption behavior: instead of simply accepting or rejecting an innovation, potential adopters may be active participants in the adoption and diffusion process, struggling to give meaning to the new information as the innovation is applied to their local context. This conception of adoption behavior, involving re-invention, is more in line with what certain respondents in diffusion research have been trying to tell researchers for many years.

Airplane Hijacking: Re-Invention in the Skies*

An unusual and interesting case of almost continuous re-invention is provided by airplane hijackings. The first act of such air piracy occurred in Peru in 1930; this was the original act of invention. But airplane hijackings really began to diffuse in early 1968, with a spate of hijackings to Cuba (Figure 5-2). During the first cycle of hijackings over the next two and one-half years, the mass media described each event in great detail, allowing future hijackers to learn useful lessons from previous attempts. About 80 percent of these seventy hijackings (occurring in 1968-1970) were successful, even though the Federal Aviation Agency (FAA) took more and more countermeasures to prevent the hijacking attempts: the screening of all airline passengers prior to boarding an aircraft, development of a profile of the typical hijacker, legal punishment for hijackers, and so on. No direct communication could have occurred among the hijackers, but thanks to the mass media accounts of each hijacking, they were able to learn which techniques of hijacking had failed or succeeded. And as soon as an FAA countermeasure blocked one technique of hijacking, a new technique would be reinvented.

At first, hijacking in the United States mostly involved flying the plane to Cuba, which was at that time romanticized as a socialist haven, with the hijackers receiving a hero's welcome in Havana. This first era of politically motivated hijackings ended, however, with the voluntary return of six hijackers from Cuba to face certain prison terms in the United States (Pitcher et al, 1978). They complained of racial discrimination and other mistreatment in Cuba.

Beginning in mid-1970, a second cycle of hijackings occurred in which ransoms were demanded in exchange for the lives of passengers. The first ransom attempt was successful, and the hijacker, D. B. Cooper, who parachuted with his ransom of $200,000 into a remote area, has become something of a popular cult hero. This extortion event set off a new set of countermeasures by the FAA and the airlines, making successful hijacking increasingly difficult, and during this second cycle the rate of success

*The illustrative reading is adapted from Hamblin et al (1973, pp. 122-126), and is used by permission.

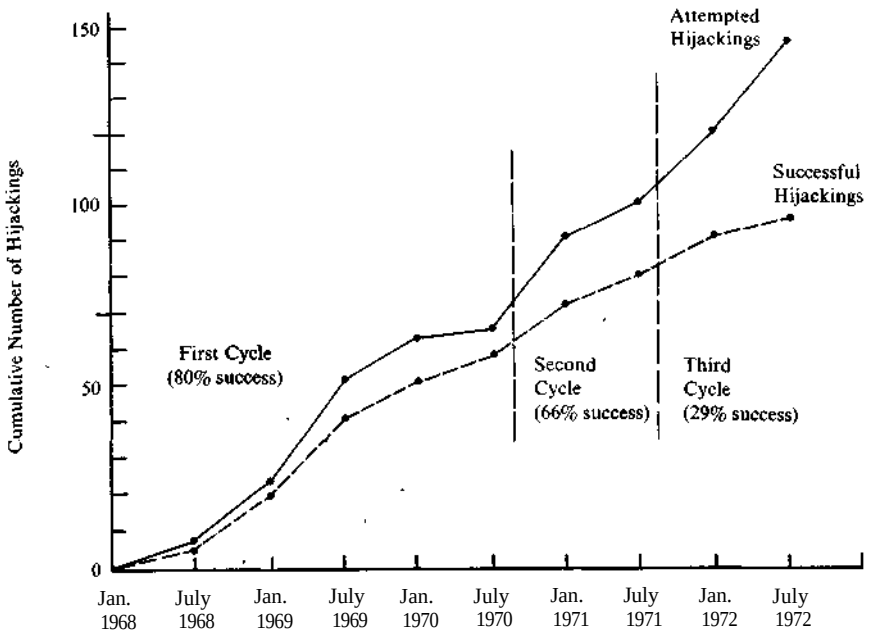

Figure 5-2. The diffusion of airplane hijacking proceeded in a series of continuous re-inventions of hijacking techniques, with each countered by prevention techniques on the part of the Federal Aviation Agency and the airlines.

During the first cycle of hijackings from 1968 through mid-1970, the usual technique was to hijack the plane to Cuba. In the second cycle from mid-1970 to mid-1971, hijackers began to demand ransom payments; the rate of hijacking success began to decline. During the third cycle from mid-1971 to mid-1972, the success rate fell to only 29 percent, as the mass media voluntarily blacked out (1) the names of the hijackers (thus stymieing their desire for national publicity), and (2) the details of the hijacking techniques, thus making re-invention more difficult.

Source: Hamblin et al (1973, p. 122), used by permission.

dropped to 66 percent (Figure 5-2). The U.S. government was learning how to crack down on hijackers in various ways.

"The role of the mass media in assisting the hijackers to learn from previous piracy attempts is perhaps best shown by the television program, *Doomsday Flight.* This drama depicted an extortionist who threatened airline officials that a pressure-sensitive bomb would explode as the plane descended to a certain altitude during landing. Telephoned bomb threats patterned after the television plot occurred after this television program was broadcast, and after it was later rerun. After a showing *of Doomsday Flight*

on Montreal television, an extortionist used the bomb threat to demand a quarter of a million dollars from an airline; he said he had planted a bomb that would explode when the plane descended to 5,000 feet. But the hijacker was foiled when the airline diverted their plane to land at Denver airport (altitude 5,339 feet). Other occurrences of the altitude-sensitive bomb threat also happened, usually shortly after showing the *Doomsday Flight program.*

During the third cycle of hijackings, in late 1971 and 1972, the FAA gained a marked superiority over each new wave of re-invented hijacking techniques, and the success rate dropped to only 29 percent (Hamblin and others, 1973, p. 125). This occurred because the mass media voluntarily agreed to black out the details of hijacking techniques. Psychiatrists who studied hijackers found that notoriety was one of their major motivations, so the media stopped publicizing the names of the air pirates. Once the desire for national publicity was blocked, the rate of attempted hijackings began to fall off (Figure 5-2).

So the continuous re-invention of hijacking methods made the control of aerial piracy by the FAA an especially difficult task. Psychiatrists consider hijackers dangerously psychotic, but also logically brilliant in working out and executing their plans. Their creative ability to re-invent new variations on the basic innovation of hijacking made the hijackers particularly difficult to control, until the American mass media made it impossible for them to learn from the trial-and-error process of the diffusion of hijacking.

Airline hijacking is relatively rare in the United States today, but the idea has spread to other countries, and international air piracy has become relatively common.

Confirmation Stage

Empirical evidence supplied by several researchers* indicates that a decision to adopt or reject is often not the terminal stage in the innovation-decision process. For example, Mason (1962a) found that his respondents, who were Oregon farmers, sought information *after* they had decided to adopt as well as before. At the confirmation stage the individual (or other decision-making unit) seeks reinforcement for the innovation decision already made, but he or she may reverse this decision if exposed to conflicting messages about the innovation. The confirmation stage continues after the decision to adopt or reject for an indefinite period in time (Figure 5-1). Throughout the confirmation stage the individual seeks to avoid a state of dissonance or to reduce it if it occurs.

*Such as Mason (1962b, 1963, 1964, 1966a, 1966b), and Francis and Rogers (1960).

Dissonance

Human behavior change is motivated in part by a state of internal disequilibrium or dissonance, an uncomfortable state of mind that the individual seeks to reduce or eliminate. When an individual feels dissonant, he or she will ordinarily be motivated to reduce this condition by changing his or her knowledge, attitudes, or actions. In the case of innovative behavior, this dissonance reduction may occur:

1. When the individual becomes aware of a felt need or problem and seeks information about some means such as an innovation to meet this need. Hence, a receiver's knowledge of a need for innovation can motivate information-seeking activity about the innovation. This occurs mainly at the knowledge stage in the innovation-decision process.

2. When the individual knows about a new idea and has a favorable attitude toward it, but has not adopted. Then the individual is motivated to adopt the innovation by the dissonance between what he or she believes and what he or she is doing. This behavior occurs at the decision and implementation stages in the innovation-decision process.

3. After the innovation-decision to adopt and implementation of the innovation, when the individual secures further information that persuades him or her that he or she should *not* have adopted. This dissonance may be reduced by discontinuing the innovation. Or if he or she originally decided to reject the innovation, the individual may become exposed to pro-innovation messages, causing a state of dissonance that can be reduced by adoption. These types of behavior (discontinuance or later adoption) occur during the confirmation function in the innovation-decision process (Figure 5-1).

These three methods of dissonance reduction consist of changing behavior so that attitudes and actions are more closely in line. But it is often difficult to change one's prior decision to adopt or reject; activities have been set in motion that tend to stabilize the original decision. Perhaps a considerable cash outlay was involved in adoption of the innovation, for instance. Therefore, individuals frequently try to avoid becoming dissonant by seeking only that information that they expect will support or confirm a decision already made. This is an example of selective exposure.* During the confirmation stage the indi-

* Similarly, dissonance can be reduced by selective perception (message distortion) and by the selective forgetting of dissonant information.

vidual wants supportive messages that will prevent dissonance from occurring, but nevertheless some information reaches the individual that leads to questioning the adoption-rejection decision made previously in the innovation-decision process.

At the confirmation stage in the innovation-decision process, the change agent has a special role. In the past, change agents have primarily been interested in achieving adoption decisions, but at the confirmation stage they have the additional responsibility of providing supporting messages to individuals who have previously adopted. Possibly one of the reasons for the relatively high rate of discontinuance of some innovations is that change agents assume that once adoption is secured, it will continue. But without continued effort there is no assurance against discontinuance, because negative messages about an innovation exist in most client systems. For example, the rate of adoption of family-planning innovations has "plateaued" and declined in several Asian nations, owing to rumors about the side effects of these contraceptives. Such negative messages at the confirmation stage in the innovation-decision process may lead to discontinuance.

Discontinuance

A *discontinuance* is a decision to reject an innovation after having previously adopted it. A rather surprisingly high rate of discontinuance has been found for several innovations. In fact, Leuthold (1967, p. 106) concluded from his study of a statewide sample of Wisconsin farmers that the rate of discontinuance was just as important as the rate of adoption in determining the level of adoption of an innovation at any particular time. In other words, for any given year there were about as many discontinuers of an innovation as there were first-time adopters. As a result, change agents have devoted increasing attention to prevent discontinuance of such innovations.

There are at least two types of discontinuances: (1) replacement and (2) disenchantment. A *replacement discontinuance* is a decision to reject an idea in order to adopt a better idea that supersedes it. In many fields, there are constant waves of innovations. And each new idea replaces an existing practice that was an innovation in its day too. Figure 5-3 shows how adoption of gammanym led to the discontinuance of two other medical drugs. Pocket calculators replaced slide

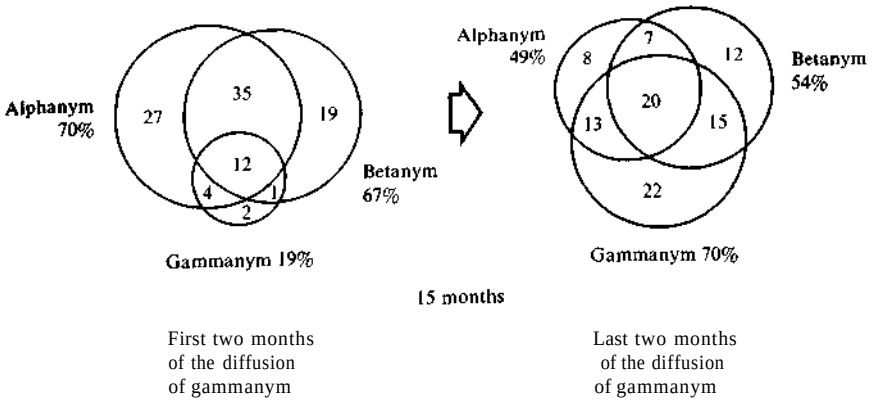

Figure 5-3. The increasing adoption of gammanym (a new drug) by medical doctors led to the replacement discontinuance of two previously used drugs.

Data are shown here for the use of gammanym, a new antibiotic drug, at the beginning and at the end of its diffusion among one hundred medical doctors in Illinois. During a period of about seventeen months, each of the physicians adopted the new drug after initially prescribing it on a very limited basis. Gammanym's use became much more important than that of alphanym and betanym, two other antibiotic drugs of the same family, as show here by the size of the circles. Here we see an example of *replacement discontinuance,* a decision to cease using an idea in order to adopt a better idea that supercedes it. But doctors did not give up using alphanym and betanym completely as gammanym made its way into their practice. Although 70 percent of the doctors were using gammanym by the end of its diffusion, only 22 percent were using gammanym exclusively.

Source: Coleman et al (1966, p. 30), used by permission.

rules. There are many examples of replacement discontinuances in everyday life.

A *disenchantment discontinuance* is a decision to reject an idea as a result of dissatisfaction with its performance. The dissatisfaction may come about because the innovation is inappropriate for the individual and does not result in a perceived relative advantage over alternative practice. Perhaps a government agency has ordered that the innovation is no longer safe and/or that it has side effects that are dangerous to health. Or discontinuance may result from misuse of an innovation that could have functioned advantageously for the individual. This later type of disenchantment seems to be more common among later adopters than among earlier adopters, who have more ed-

ucation and an understanding of the scientific method, so they know how to generalize the results of an innovation's trial to its full-scale use. Later adopters also have fewer resources, which may either prevent adoption or cause discontinuance because the innovations do not fit their limited financial position.

This reasoning is consistent with the findings of Johnson and van den Ban (1959), Leuthold (1965, 1967), Bishop and Coughenour (1964), Silverman and Bailey (1961), and Deutschmann and Havens (1965), which supports Generalization 5-9: *Later adopters are more likely to discontinue innovations than are earlier adopters.*

Researchers previously assumed that later adopters are relatively less innovative because they did not adopt or were slower to adopt. But the evidence on discontinuances suggests that many laggards adopt but then discontinue, usually owing to disenchantment. For instance, Bishop and Coughenour (1964) reported that the percentage of discontinuance for Ohio farmers ranged from 14 percent for innovators and early adopters, to 27 percent for early majority, to 34 percent for late majority, to 40 percent for laggards. Leuthold (1965) reported comparable figures of 18 percent, 24 percent, 26 percent, and 37 percent, respectively, for Canadian farmers.

Several investigators * have determined the characteristics of individuals with a high and a low rate of discontinuance. Generally, high discontinuers have less education, lower socioeconomic status, less change agent contact, and the like, which are the opposites of the characteristics of innovators (Chapter 7). Discontinuers share the same characteristics as laggards, who indeed have a higher rate of discontinuance.

The discontinuance of an innovation is one indication that the idea may not have been fully institutionalized and routinized into the ongoing practice and way of life of the adopter at the implementation stage of the innovation-decision process. Such routinization is less likely (and discontinuance is more frequent) when the innovation is less compatible with the individual's beliefs and past experiences. Perhaps (1) there are innovation-to-innovation differences in rates of discontinuance, just as there are such differences in rates of adoption, and (2) the perceived attributes of innovations (for example, relative advantage and compatibility) are negatively related to the rate of discontinuance. For instance, we expect an innovation with a low relative

*For example, Leuthold (1967), Leuthold (1965), Deutschmann and Havens (1965), and Wilkening (1952).

advantage to have a slow rate of adoption and a fast rate of discontinuance. And innovations that have a high rate of adoption should have a low rate of discontinuance. The findings of Coughenour (1961), Silverman and Bailey (1961), Johnson and van den Ban (1959), and Leuthold (1965) support Generalization 5-10: *Innovations with a high rate of adoption have a low rate of discontinuance.*

Forced Discontinuance of Innovations

A unique and theoretically interesting type of discontinuance has occurred in fairly recent years with bans on the use of certain innovations by federal regulatory agencies, especially the Food and Drug Administration. Such forced, immediate discontinuance often results from research results that indicate a chemical innovation may cause cancer or involve some other threat to consumer health.

In 1954, for my Ph.D. dissertation study, I gathered data from 148 farmers in an Iowa farm community about their adoption of such agricultural innovations as 2,4-D weed spray, antibiotic swine-feeding supplements, diethyl-stibestrol (DES) for cattle feeding, and chemical fertilizers. These chemical innovations represented the wave of post-World War II agricultural technologies that were recommended to farmers by agricultural scientists at Iowa State University and by the Iowa extension service. The impact of these innovations brought about an "agricultural revolution" in farm production during the 1950s and 1960s, such that one of the main problems for U.S. agriculture was then to dispose of the crop surpluses that accumulated in government grain storage bins.

In 1954, like most other diffusion investigators, I accepted the recommendations of the agricultural scientists about these chemical innovations as valid. So did most of the Iowa farmers that I interviewed in my diffusion study. I remember, however, one farmer who had rejected all of these agricultural chemicals because, he claimed, they killed the earthworms and songbirds in his fields. At the time, I personally regarded his organic attitudes as irrational; certainly his farming behavior was measured as "traditional" by my innovativeness scale (composed of a dozen or so agricultural innovations recommended by agricultural experts).

A few years later, when I read Rachel Carson's (1962) book, *Silent Spring*, I regarded her antichemical argument as extreme and absurd. I agreed with an agronomist friend of mine who called Carson "a very dangerous and mistaken woman, who is a threat to the progress of American agriculture."

But the rise of the environmental movement in the United States in the 1960s and the results of certain researches on the long-term effects of agricultural chemicals began to make me wonder. In 1972, the U.S. Environ-

mental Protection Agency banned the use of DDT as an insecticide because of its threats to human health (Dunlap, 1981). In following years, DES was banned for cattle feeding, as were antibiotic swine-feeding supplements, and 2,4,5-D weed spray. The concentration of such chemicals was found to increase owing to biomagnification in the food chain, until levels dangerous to human health sometimes occurred.

An increasing proportion of U.S. consumers who preferred to pay a premium price for organically grown foods patronized health food stores. Correspondingly, the number of organic farmers and gardeners increased, as a result of growing distrust in the effects of chemical pesticides and fertilizers. By 1980, an estimated 30,000 U.S. farmers (about 1 percent of the total) considered themselves "organic farmers." They achieved somewhat lower crop yields than "chemical farmers," but their costs of production were also lower (in part because of the rise in the costs of pesticides and fertilizers, tracing from the sharp increase in petroleum prices), and they often could secure an increased price for their organic food production from natural food stores.

In 1980, the U.S. Department of Agriculture reversed its policy of opposing organic farming and gardening, and began to advise U.S. farmers and gardeners to consider alternative production methods that used fewer chemicals.* The USDA also began a research program to develop appropriate seed varieties for organic farming and gardening (U.S. Department of Agriculture, 1980). Surveys of organic farmers indicated that most were not "hippies," nor were they lower-educated traditionalists; in fact, most organic farmers are commercial operators with the general characteristics of progressive farmers (such as above-average education, larger farms, and so on). Nevertheless, most organic farmers at present are viewed by their neighbors as deviants from conventional farming practices (Lockeretz et al, 1981; Lockeretz and Wennick, 1980).

For several years prior to the 1980 policy reversal, the USDA had realized that chemical pesticides were overused by many farmers, and had accordingly launched a program called "integrated pest management" (IPM). A key factor in initiating the IPM program was the fact that over 400 varieties of insects have developed resistance to existing pesticides, along with a concern with the consumer health problems resulting from biomagnification through food chains. Integrated pest management consists of careful scouting of a farmer's fields, usually by trained scouts, who advise the farmer when a pest problem has increased above an economic threshold, and

*This policy reversal was initiated by then U.S. Secretary of Agriculture Bob Berglund, as a result of his contact with a farmer friend in Minnesota who farmed 1,500 acres organically. Secretary Berglund ordered a study of U.S. organic farmers, who were matched with a sample of neighboring "chemical farmers" on similar soils and who produced similar crops. The results of this study helped convince the USDA to reverse its previous antiorganic policy.

when spraying with a chemical pesticide would thus be justified. Farmers who adopt IPM typically report important savings from decreased use of pesticides. Some large farmers may save thousands of dollars.

Today, looking back to my 1954 Iowa diffusion investigation, the organic farmer whom I interviewed certainly has had the last laugh over agricultural experts. My research procedures classified him as a laggard in 1954; by present-day standards he was a superinnovator in organic farming.

The forced discontinuance of various chemical innovations in recent years, caused by rulings of such federal agencies as the Food and Drug Administration, suggests important issues to diffusion researchers:

1. What is the effect of such a forced discontinuance on the perceived credibility of the diffusion agency, like the agricultural extension services, that had previously promoted the innovation that is now banned?
2. Does such a forced discontinuance of a chemical innovation lead to a general loss of faith in science and research on the part of the discontinuers?
3. What role does such forced discontinuance play in motivating the adoption of alternative innovations (such as organic farming)? *

Although we have used agricultural chemical innovations in this section to illustrate forced discontinuance, and we have discussed the impact of such discontinuance on farmer behavior, there is also undoubtedly an effect on food consumers. For instance, is the rise of natural food consumption due in part to the consumer health problems that have been found to be associated with DDT, 2,4,5-D, DES, and other agricultural chemicals?

The technological vulnerability of certain nonagricultural innovations has also been demonstrated by events in recent years: the Three-Mile-Island disaster, side effects of the oral contraceptive pill and the Dalkon shield (an IUD), the Santa Barbara oil spill, saccharin in soft drinks, and the recall of numerous autos, tires, and other consumer products. What is the net effect of these forced discontinuances on the public mind?

Are There Stages in the Process?

What empirical evidence is available that the stages posited in our model of the innovation-decision process (Figure 5-1) exist in reality?

* This research question was pursued by Mason and Halter (1980), who gathered data from forty-four Oregon grass-seed growers when air pollution authorities in the Willamette Valley banned field burning of postharvest crop residues as a means of grass-disease control in 1975. This ruling led to adoption of a new machine, the field sanitizer, as a means of disease control.

Before we seek to answer this question, we should point out that a really definitive answer is difficult to provide. It is not easy for a researcher to probe the mental processes of individual respondents. Nevertheless, there is tentative evidence from several studies that the concept of stages in the innovation-decision process is supported.

Evidence of the Stages

Empirical evidence of the validity of stages in the innovation-decision process comes from an Iowa study (Beal and Rogers, 1960) that shows that most farmer-respondents recognized that they went through a series of stages as they moved from awareness-knowledge to a decision to adopt.* Specifically, they realized that they had received information from different sources and channels at different stages. Of course, it is possible for an individual to use the same sources or channels, perhaps in a different way, at several functions in the innovation-decision process. If, however, respondents report different sources or channels at each function, this tends to indicate some differentiation of the functions. Beal and Rogers (1960) found that all their respondents reported different communication channels for two agricultural innovations at the knowledge and at the decision functions, and there was a good deal of channel differentiation between the knowledge and persuasion stages. There are many other research studies, reviewed later in this chapter, that also indicate a differentiation of channels at different stages in the innovation-decision process.

Beal and Rogers (1960) also found that none of their 148 respondents reported adopting immediately after becoming aware of the two new farm ideas. Instead, 73 percent of the adopters of a new weed spray and 63 percent of the adopters of a new livestock feed, reported different years for knowledge and for the decision to adopt. Most individuals seemed to require a period of time that could be measured in years to pass through the innovation-decision process. This provides some indication that adoption behavior is a process that contains various stages and that these stages occur over time.

Yet another type of evidence provided by Beal and Rogers (1960) deals with skipped stages. If most respondents report not having

* Actually there is nothing inherent in the conception of stages in the innovation-decision process that would require that individuals passing through the process would realize just what stage they are at, as Dr. J. D. Eveland of the National Science Foundation has pointed out.

passed through a stage in the innovation-decision process for a given innovation, some question would thus be raised as to whether that stage should be included in the model. Beal and Rogers found, however, that most farmers described their behavior at each of the first three stages in the process: knowledge, persuasion, and decision. None reported skipping the knowledge or decision stages, but a few farmers did not seem to pass through the persuasion function, and some did not report a trial prior to adoption.

Similar evidence to that of Beal and Rogers (1960) for the existence of stages in the innovation-decision process is provided by Mason (1962b, 1963,1964,1966a, 1966b), Beal et al(1957), Wilkening(1956), and Copp et al (1958) among U.S. farmers, and by Rahim (1961) and Singh and Pareek (1968) among Asian villagers. One limitation is that all of these studies deal with farmer respondents. How do we know that our innovation-decision process model also describes the behaviors of other types of individuals and other kinds of innovations? Fortunately, we now have additional studies of nonfarmers. For example, one is of physicians (Coleman et al, 1966) and two are of school personnel (LaMar, 1966; Kohl, 1966); the results generally support the validity of stages in the innovation-decision process. For instance, Coleman et al (1966) found that most physicians reported different communication channels about a new drug at the knowledge function from those reported at the persuasion function. LaMar (1966, p. 72) studied the innovation-decision process among 262 teachers in 20 California schools. He found that the teachers went through the stages in the process, much as had been found in the studies of farmers. Kohl (1966, p. 68) found that all fifty-eight Oregon school superintendents in his sample reported that they passed through all the stages for such innovations as team teaching, language laboratories, and flexible scheduling.

In summary, we suggest Generalization 5-11: *Stages exist in the innovation-decision process.* The evidence is most clear-cut for the knowledge and decision stages and somewhat less so for the persuasion stage. There are rather poor data on distinctiveness of the implementation and confirmation stages. Given the importance of the stages concept in diffusion research, it is rather puzzling that more research has not been directed toward understanding the innovation-decision process. Perhaps it is because the "process" nature of this research topic does not fit the "variance" type of research methods used by most diffusion researchers.

Variance and Process Research

Research designed to answer the question of whether stages exist in the innovation-decision process obviously needs to be quite different from the study of the independent variables associated with the dependent variable of innovativeness. The first *is process research,* defined as a type of data gathering and analysis that seeks to determine the time-ordered sequence of a set of events. In contrast, *variance research* is a type of data gathering and analysis that consists of determining the co-variances among a set of variables, but not their time-order.

Most diffusion research (and in fact, most social science research) is variance-type investigation. It uses highly structured data gathering and quantitative data analysis of cross-sectional data, such as comes from one-shot surveys. Because only one point in time is represented in the data, variance in a dependent variable is related to the variance in a set of independent variables. Variance research is entirely appropriate for investigating certain research problems, such as to determine variables related to innovativeness (Chapter 7). But it cannot probe backward in time to understand what happened first, next, and so on, and how each of these events influenced the next.

Variance research, thus, is inappropriate for exploring the nature of the innovation-decision process. Here one needs a dynamic perspective to explain the causes and sequence of a series of events over time. Data-gathering methods in process research are usually less structured and the data are typically more qualitative in nature, than they are in variance research. Seldom are statistical methods used to analyze the data in process research.

Most of the research reported in this chapter is basically process, as it must be. But diffusion scholars have frequently failed to recognize the important distinction between variance and process research in the past, and Mohr (1978) has performed an important intellectual service for the field of diffusion research by pointing out the main differences. In fact, Mohr shows that variance and process approaches have often been confused in the past, with, for example, attempts to use variance research to understand a process.

Process research has been used in a series of recent studies of the innovation-decision process in organizations, which we shall review in Chapter 10. Here, instead of studying the characteristics of more innovative and less innovative organizations (a variance approach to investigating innovativeness), diffusion scholars have conducted

"tracer" studies of a process nature in which less-structured methods are used to gather data about the sequence of events, decisions, and actions. This process research provides understanding into the special nature of the innovation-decision process in organizations. Note that the unit of analysis is no longer the organization (as it was in the studies of organizational innovativeness), but the innovation-decision process in an organization. If one were studying the adoption of 10 innovations in 100 organizations, there would be 1,000 innovation-decisions to investigate (Downs and Mohr, 1976).

The general point here is that research on a process like the innovation-decision process must be quite different from the variance research that has predominated in the diffusion field in the past. And the first step toward gaining a better understanding of the innovation-decision process, both at the individual level and at the organizational level, is to recognize that the appropriate research design is for process research.

We turn now to the role of different communication channels in the innovation-decision process.

Communication Channels in the Innovation-Decision Process for Gammanym*

Particular insight into the role of different communication channels at various stages of the innovation-decision process is provided by the classic study of the diffusion of gammanym, a new antibiotic "wonder drug," among the doctors in a medical community (Coleman et al, 1966). This innovation was spectacular in its results, and it was adopted very rapidly. Within two months of its release, 15 percent of the physicians had tried it; this figure reached 50 percent four months later, and by the end of seventeen months, gammanym dominated the doctors' antibiotic prescriptions (as we saw previously in Figure 5-3). Because gammanym had such a striking relative advantage over previous antibiotic drugs, we might expect that most of a doctor's peer networks would typically convey very positive messages about the innovation to him or her. In fact, one of the most important contributions of the drug study was to establish the importance of interpersonal networks as a communication channel in the innovation-decision process.

Information that creates awareness-knowledge of an innovation seldom comes to individuals from a source or channel of communication that they must actively seek (as we showed earlier in this chapter). Information about a new idea can only be actively sought by individuals (1) after they are aware that the new idea exists, and (2) when they know which sources or channels

*This illustrative reading is based on Coleman et al (1966).

can provide information about the innovation.* Further, the relative importance of different sources or channels of communication about an innovation depends in part, obviously, on what is available to the audience of potential adopters. For example, if a new idea is initially promoted only by the commercial firm that sells it, it is unlikely that other sources or channels will be very important, at least at the knowledge stage of the innovation-decision process. Coleman et al (1966, p. 53) found that 80 percent of the medical doctors in their drug study reported first learning about gammanym from drug companies (57 percent from pharmaceutical detail men, 18 percent from drug-house mailings, 4 percent from drug-house magazines, and 1 percent from drug ads in medical journals).

But later in the innovation-decision process, at the persuasion and decision stages, near-peer networks were the major sources or channels of communication about the new drug and the commercial role was unimportant. Information that a new drug existed could be credibly communicated by commercial sources or channels, but doctors relied on the experiences of their peers, conveyed via interpersonal networks, for evaluative information about the innovation. They did not regard the pharmaceutical firms that sold gammanym as credible sources or channels for such evaluative information. Adopters of other types of innovations have been found similarly to depend on near-peers rather than commercial or other change agents at the persuasion and decision stages of the innovation-decision process.

Scientific evaluations of gammanym were communicated to the doctors, but such information did not convince them to adopt the innovation. Coleman et al (1966) concluded that "the extensive trials and tests by manufacturer, medical schools, and teaching hospitals—tests that a new drug must pass before it is released—are not enough for the average doctor" (pp. 31-32). They found that "testing at the expert level cannot substitute for the doctor's own testing of the new drug; but testing through the everyday experiences of colleagues on the doctor's own level can substitute, at least in part" (p. 32). Again, we see that individuals depend on near-peers for innovation-evaluation information, which decreases their uncertainty about the innovation's expected consequences.

One type of evidence that the interpersonally communicated experience of near-peers can substitute, in part, for one's personal experience with an innovation is provided by analyses of the degree to which earlier versus later

*One way to classify communication channels (in addition to interpersonal versus mass media) is whether they are "active" or "passive." *Passive communication channels* provide information to an individual about an innovation's existence, how it works, where it can be obtained, and how to adopt it. This information is applicable to a mass audience, and so the mass media can be effective in disseminating it. *Active communication channels* provide information to an individual that motivates him or her to adopt. Active channels carry messages that are tailored closely to the particular needs of an individual. Thus, active channels are often interpersonal network links. So the active/passive channel classification often corresponds closely to the mass media/interpersonal categorization.

adopters of an innovation use the new idea completely at the time of their first trial. A common finding from several diffusion studies is that innovators are much more tentative in adopting an innovation than later adopters. For example, the first medical doctors to adopt gammanym did so on a very partial basis; the nineteen physicians who adopted the new drug in the first and second months of its use only wrote prescriptions for an average of 1.5 patients. The twenty-two doctors who adopted the innovation in the third and fourth months wrote 2.0 prescriptions, while the twenty-three doctors adopting in the fifth through the eighth month wrote an average of 2.7 prescriptions (Coleman et al, 1966, p. 32).*

Why are the first individuals in a system to adopt an innovation usually most tentative in their degree of trial use of the new idea? The answer lies in the role of uncertainty in the diffusion process. Even though the most innovative adopters of gammanym and hybrid corn were fully informed of the scientific evaluations that had been made of the new idea, this information did not reduce their uncertainty about how the innovation would work for doctors or for farmers. The innovators had to conduct their own personal experimentation with the new idea in order to assure themselves that it was indeed advantageous. They could not depend on the experience of peers with the innovation, because no one else had adopted the innovation at the time that the innovators adopted. But later adopters can profit from their peers' accumulated personal experiences with the innovation; thus, much of the uncertainty of the innovation is removed by the time the later adopters first use a new idea, making a personal trial of the new idea less necessary for them.

Communication Channels by Stages **in the** Innovation-Decision Process

One importance of the five stages in the innovation-decision process is to help our understanding of the role of different communication channels, as was just illustrated in the case of gammanym.

Categorizing Communication Channels

It is often difficult for individuals to distinguish between the source of a message and the channel that carries the message. A *source* is an in-

* Similarly, Ryan (1948) found that Iowa farmers adopting hybrid corn prior to 1939 initially planted only 15 percent of their corn acreage with hybrids, but those who adopted in 1939 and 1940 planted 60 percent of their acreage in hybrid seed in their first year of adoption. This figure was 90 percent for those starting in 1941-1942 (the laggards).

dividual or an institution that originates a message. A *channel* is the means by which a message gets from a source to a receiver. In the present section, we mainly speak of "channels," but often "source/channel" would probably be more accurate.

Researchers categorize communication channels as either (1) interpersonal or mass media in nature, or (2) originating from either localite or cosmopolite sources. Past research studies show that these channels play different roles in creating knowledge or in persuading individuals to change their attitude toward an innovation. The channels also are different for earlier adopters of new ideas than for later adopters.

Mass media channels are all those means of transmitting messages that involve a mass medium, such as radio, television, newspapers, and so on, which enable a source of one or a few individuals to reach an audience of many. Mass media can:

1. Reach a large audience rapidly.
2. Create knowledge and spread information.
3. Lead to changes in weakly held attitudes.

The formation and change of strongly held attitudes, however, is best accomplished by interpersonal channels. *Interpersonal channels* involve a face-to-face exchange between two or more individuals. These channels have greater effectiveness in dealing with resistance or apathy on the part of the communicatee. What can interpersonal channels do best?

1. Provide a two-way exchange of information. One individual can secure clarification or additional information about the innovation from another individual. This characteristic of interpersonal networks sometimes allows them to overcome the social-psychological barriers of selective exposure, perception, and retention.
2. Persuade an individual to form or to change a strongly held attitude. This role of interpersonal channels is especially important in persuading an individual to adopt an innovation.

Mass Media Versus Interpersonal Channels

Generalization 5-12 states: *Mass media channels are relatively more important at the knowledge stage and interpersonal channels are relatively more important at the persuasion stage in the innovation-decision process.* The importance of interpersonal and mass media channels in the innovation-decision process was first investigated in a series of researches with farmers, and then largely confirmed in studies of other types of respondents. For example, Sill (1958) found that if the probability of adoption were to be maximized, communication channels must be used in an ideal time sequence, progressing from mass media to interpersonal channels. Copp et al (1958, p. 70) found that "A temporal sequence is involved in agricultural communication in that messages are sent out through media directed to awareness, then to groups, and finally to individuals. A farmer upsetting this sequence in any way prejudices progress at some point in the adoption process." The greatest thrust out from the knowledge stage was provided by the use of the mass media, while interpersonal channels were salient in moving individuals out of the persuasion stage. Using a communication channel that was inappropriate to a given stage in the innovation-decision process (such as an interpersonal channel at the knowledge stage) was associated with later adoption of the new idea because such channel use delayed progress through the process.

Data on the relative importance of interpersonal and mass-media channels at each function in the adoption of 2,4-D weed spray were obtained by Beal and Rogers (1960, p. 6) from 148 Iowa farmers. Mass-media channels, such as farm magazines, bulletins, and container labels, were more important than interpersonal channels at the knowledge function for this innovation. The percentage of respondents mentioning an interpersonal channel increased from 37 percent at the knowledge function to 63 percent at the persuasion function.

The evidence just presented in support of Generalization 5-12 came from research done in the United States, where the mass media are widely available. The first condition, however, for mass media effects—availability of the media—may not be met in many developing countries. For example, Deutschmann and Fals Borda (1962b, p. 33) found that interpersonal channels were heavily used even at the knowledge function by Colombian villagers. In Bangladesh villages, Rahim (1961, 1965) found that mass media channels were seldom mentioned as channels about agricultural innovations, whereas cosmopolite interpersonal channels were very important, and *in some ways seemed to perform a similar role to that played by mass media channels in more developed countries.* An example of a cosmopolite interpersonal channel is an Iowa farmer attending a farm machinery

show in Des Moines, or a doctor traveling to an out-of-town medical specialty meeting.

Rogers with Shoemaker (1971, p. 257) made a comparative analysis of the role played by mass media and cosmopolite interpersonal channels by stages in the innovation-decision process for twenty-three different innovations (mostly agricultural) in the United States, Canada, India, Bangladesh, and Colombia.* Mass media channels are of relatively greater importance at the knowledge function in both developing and developed countries, although there is a higher *level of* mass media channel usage in the developed nations, as we would expect. Mass media channels are used by 52 percent of the respondents at the knowledge stage in developed nations, falling to 15 percent at the persuasion stage, and 18 percent at the decision stage. The comparable figures for respondents in developing nations are 29 percent, 6 percent, and 8 percent. This meta-research showed that cosmopolite interpersonal channels were especially important at the knowledge stage in developing nations, as Rahim's (1961, 1965) work had suggested.

Cosmopolite Versus Localite Channels

Generalization 5-13: *Cosmopolite channels are relatively more important at the knowledge stage, and localite channels are relatively more important at the persuasion stage in the innovation-decision process.* Cosmopolite communication channels are those from outside the social system being investigated; other channels about new ideas reach individuals from sources inside their social system. Interpersonal channels may be either local or cosmopolite, while mass media channels are almost entirely cosmopolite. The meta-research for twenty-three different innovations in ten nations (mentioned previously) shows that if cosmopolite interpersonal and mass media channels are combined to form the composite category of cosmopolite channels, in the developed nations the percentage of such channels is 81 percent at the knowledge function and 58 percent at the persuasion function. In developing nations, the percentages are 74 percent at the knowledge function and 34 percent at the persuasion function. These meta-research data hint that the role played by mass media channels in

*This meta-research includes the following studies: Beal and Rogers (1957), Rogers and Meynen (1965), Ryan and Gross (1943), Sawhney (1966), Singh and Jha (1965), and Wilkening (1956).

developed countries (creating awareness-knowledge) is perhaps partly replaced by cosmopolite-interpersonal channels in developing countries. These channels include change agents, visits outside the local community, and visitors to the local system from the city.

Communication Channels by Adopter Categories

The preceding discussion of communication channels by functions in the innovation-decision process ignored the effects of the respondents' adopter category. Now we probe channel usage by different adopter categories.

Generalization 5-14: *Mass media channels are relatively more important than interpersonal channels for earlier adopters than for later adopters.* This generalization seems logical, since at the time that innovators adopt a new idea there is almost no one else in the system who has experience with the innovation. Later adopters do not need to rely so much on mass media channels because a bank of interpersonal, local experience has accumulated in their system by the time they decide to adopt. Perhaps interpersonal influence is not so necessary to motivate earlier adopters to decide favorably on an innovation. They possess a need for venturesomeness, and the mass media message stimulus is enough to move them over the mental threshold to adoption. But the less change-oriented, later adopters require a stronger and more immediate influence, like that from interpersonal networks.

There is strong support for Generalization 5-14 from researches in both developed and developing nations. Data illustrating the proposition are shown in Figure 5-4 for the adoption of a weed spray by Iowa farmers.

Reasoning similar to that just presented leads to Generalization 5-15: *Cosmopolite channels are relatively more important than localite channels for earlier adopters than for later adopters.* * Innovations enter a system from external sources; those who adopt first are more likely to depend upon cosmopolite channels. These earlier adopters, in turn, act as interpersonal and localite channels for their later adopting peers.

*This proposition bears close resemblance to Generalization 7-25, which states that earlier adopters are more cosmopolite than later adopters. Generalization 5-14, however, refers to cosmopolite *channel* usage, rather than to cosmopolite behavior in general.

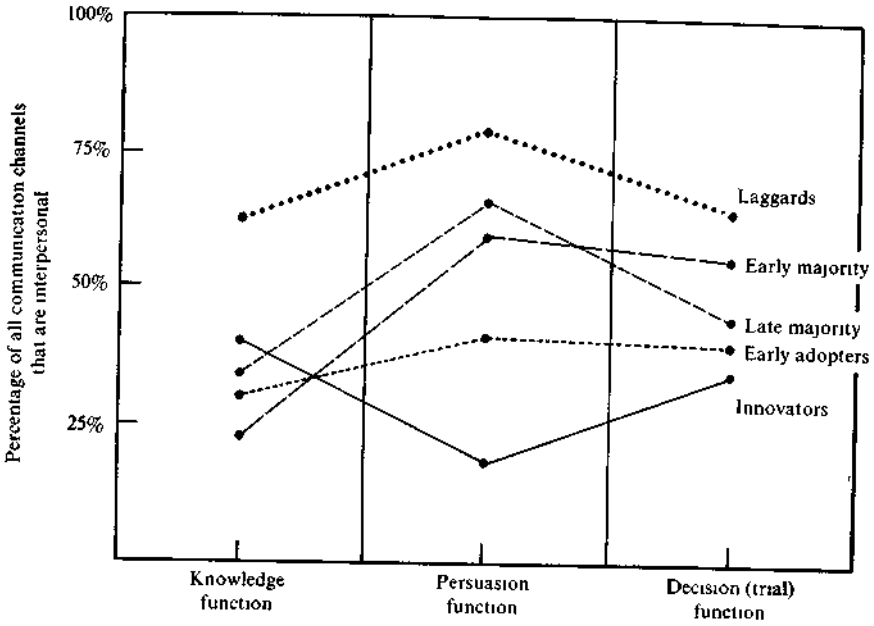

Figure 5-4. Interpersonal channels are relatively less important for earlier adopters than for later adopters of 2,4-D weed spray in Iowa.

Source: Beal and Rogers (1960, p. 19), used by permission.

The Innovation-Decision Period

The *innovation-decision period* is the length of time required to pass through the innovation-decision process.* The time elapsing from awareness-knowledge of an innovation to decision for an individual is measured in days, months, or years. The period is thus a gestation period during which a new idea ferments in an individual's mind.

Rate of Awareness-Knowledge and Rate of Adoption

Most change agents wish to speed up the process by which innovations are adopted. One method for doing so is to communicate information

*The length of the innovation-decision period is usually measured from first knowledge until the decision to adopt (or reject), although in a strict sense it should perhaps be measured to the time of confirmation. This later procedure is often impractical or impossible because the confirmation function may continue over an indefinite period.

about new ideas more rapidly or more adequately so that knowledge is created at an earlier date. Another method is to shorten the amount of time required for the innovation-decision after an individual is aware of a new idea. Many potential adopters are often aware of an innovation but are not motivated to try it. For example, almost all of the Iowa farmers in the hybrid corn study heard about the innovation before more than a handful were planting it. "It is evident that.. .isolation from knowledge was not a determining factor in late adoption for many operators" (Ryan and Gross, 1950, p. 679). Shortening the innovation-decision period is thus one of the main methods of speeding the diffusion of an innovation.

Figure 5-5 illustrates the interrelationships between rate of awareness-knowledge, rate of adoption, and the innovation-decision period for a new weed spray. The slope of the curve for rate of awareness-knowledge is steeper than that for the rate of adoption. These data, along with evidence from supporting studies, suggest Generalization 5-16: *The rate of awareness-knowledge for an innovation is more rapid than its rate of adoption.* When looked at in another way, these data (in Figure 5-5) indicate that later adopters have longer innovation-decision periods than earlier adopters, a point to which we shall soon return.

There is a great deal of variation in the average length of the innovation-decision period from innovation to innovation. For instance, 9.0 years was the average period for hybrid corn in Iowa (Gross, 1942, p. 57), while 2.1 years was the average for the weed spray depicted in Figure 5-5 (Beal and Rogers, 1960, p. 10). How can we explain these differences? Innovations with certain characteristics are generally adopted more quickly; they have a shorter innovation-decision period. For example, innovations that are relatively simple in nature, divisible for trial, and compatible with previous experience usually have a shorter period than innovations that lack these characteristics. The main dimension of analysis in the following discussion, however, is individual difference in length of the innovation-decision period, rather than difference in this period among various innovations.

Length of the Period by Adopter Category

One of the important individual differences in length of the innovation-decision period is on the basis of adopter category. We pointed

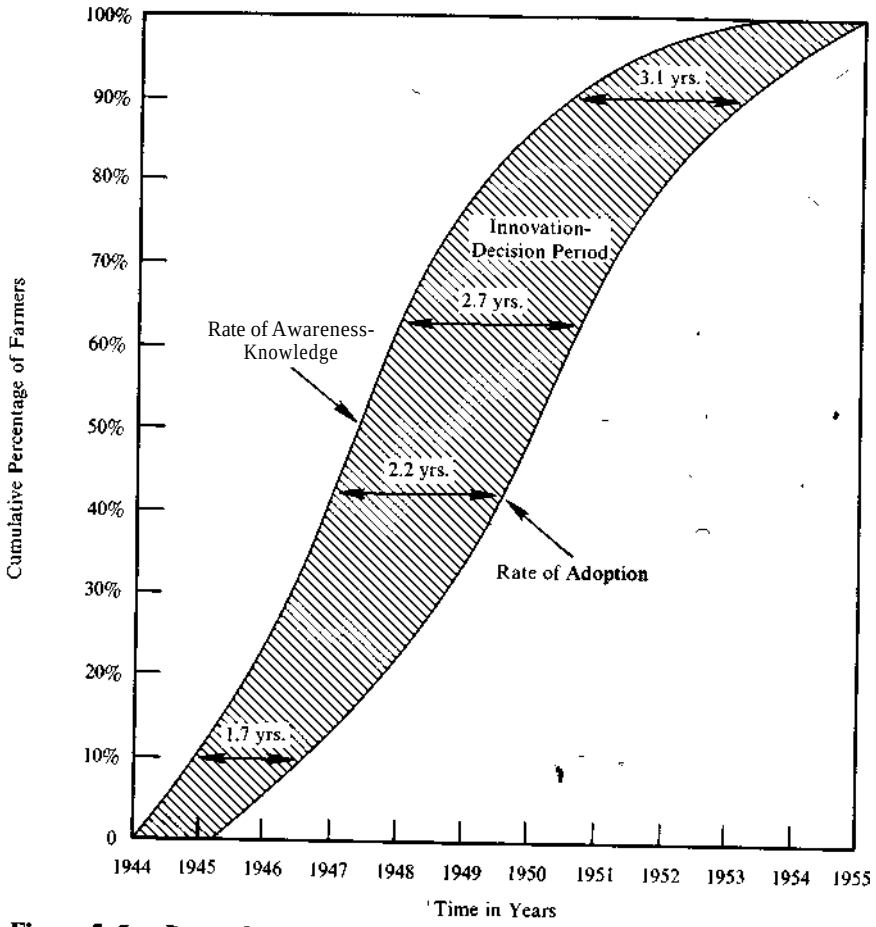

Figure 5-5. Rate of awareness-knowledge, rate of adoption, and length of the innovation-decision period for Iowa farmers adopting a weed spray by year.

The shaded area in this figure illustrates the aggregate innovation-decision period between awareness-knowledge and adoption of a weed spray. Knowledge proceeds at a more rapid rate than does adoption. This suggests that relatively later adopters have a longer average innovation-decision period than earlier adopters. For example, there are 1.7 years between 10 percent awareness and 10 percent adoption, but 3.1 years between 92 percent awareness and 92 percent adoption.

Source: A reanalysis of data originally gathered by Beal and Rogers (1960, p. 8), and used by permission.

out previously that the data in Figure 5-5 show a longer period for later adopters. We show this relationship in greater detail in Figure 5-6, where the average length of the period is shown for the five adopter categories. These data and those from several other studies support Generalization 5-17: *Earlier adopters have a shorter innovation-decision period than later adopters.* Thus, the first individuals to adopt a new idea (the innovators) do so not only because they become aware of the innovation somewhat sooner than their peers (Figure 5-5), but also because they require fewer months or years to move from knowledge to decision. Innovators perhaps gain part of their innovative position (relative to later adopters) by learning about innovations at an earlier time, but the present data also suggest that innovators are the first to adopt because they require a shorter innovation-decision period.

Why do innovators require a shorter period? Research studies show that innovators have more favorable attitudes toward new ideas and so less resistance to change must be overcome by communication messages about the new ideas. Innovators may also have shorter inno-

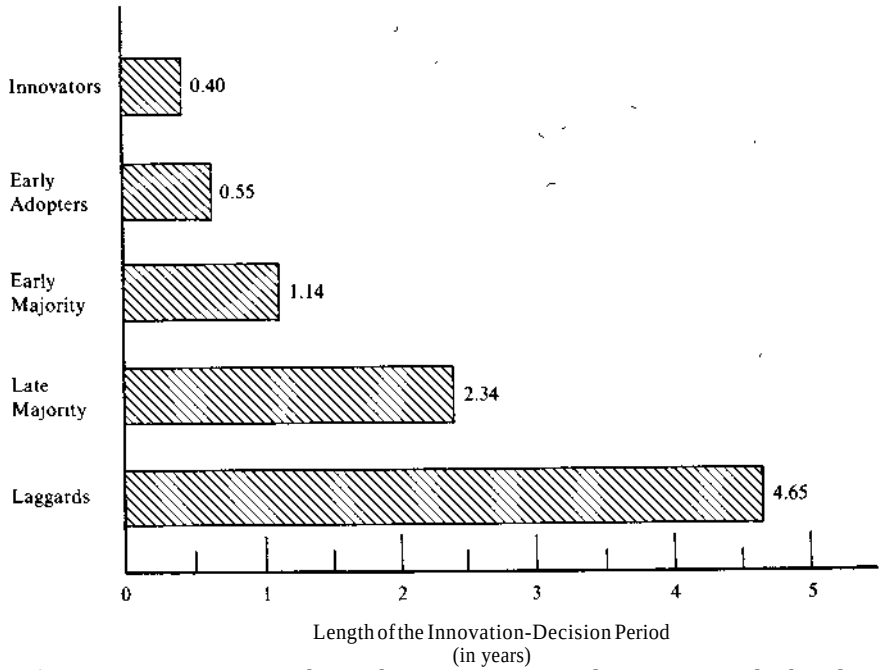

Figure 5-6. Innovators have shorter innovation-decision periods than laggards.

Source: Beal and Rogers (1960, p. 14), used by permission.

vation-decision periods because (1) they use more technically accurate sources and channels about innovations, such as direct contact with scientists, and (2) they place higher credibility in these sources than the average individual. Innovators may also possess a type of mental ability that better enables them to cope with uncertainty and to deal with abstractions. An innovator must be able to conceptualize relatively abstract information about innovations and apply this new information to his or her own situation. Later adopters can observe the results of innovations by earlier adopters and may not require this type of mental ability.

Summary

The *innovation-decision process* is the process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision. This process consists of five stages: (1) *knowledge*—the individual (or other decision-making unit) is exposed to the innovation's existence and gains some understanding of how it functions; (2) *persuasion*—the individual (or other decision-making unit) forms a favorable or unfavorable attitude toward the innovation; (3) *decision*—the individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation; (4) *implementation*—the individual (or other decision-making unit) puts an innovation into use; and (5) *confirmation—the* individual (or other decision-making unit) seeks reinforcement for an innovation-decision already made, but he or she may reverse this decision if exposed to conflicting messages about the innovation.

Earlier knowers of an innovation, when compared to later knowers, are characterized by more education, higher social status, greater exposure to mass media channels of communication, greater exposure to interpersonal channels of communication, greater change agent contact, greater social participation, and more cosmopoliteness. Generalizations 5-1 to 5-7, with a summary of the evidence for each, are detailed in Table 5-1.

Re-invention is the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation. Re-invention occurs at the implementation stage for certain innovations and for certain adopters (Generalization 5-8).

Table 5-1. A Summary of the Evidence Supporting and Not Supporting Generalizations about the Innovation-Decision Process.

Generalization	Support for the Generalization (Number of Research Studies)		Percentage of Research Studies Supporting the Generalization
	Supporting	*Not Supporting*	
5-1: Earlier knowers of an innovation have more education than later knowers.	17	7	71
5-2: Earlier knowers of an innovation have higher social status.	18	10	64
5-3: Earlier knowers of an innovation have more exposure to mass media channels of communication.	18	11	62
5-4: Earlier knowers of an innovation have more exposure to interpersonal channels of communication.	16	2	89
5-5: Earlier knowers of an innovation have more change agent contact.	13	3	81
5-6: Earlier knowers of an innovation have more social participation.	11	2	85
5-7: Earlier knowers of an innovation are more cosmopolite.	5	0	100
5-8: Re-invention occurs at the implementation stage for certain innovations and for certain adopters.	20	0	100
5-9: Later adopters are more likely to discontinue innovations than earlier adopters.	6	0	100
5-10: Innovations with a high rate of adoption have a low rate of discontinuance.	4	0	100

(*cont.*)

Table 5-1. (*cont.*)

Generalization	Support for the Generalization (Number of Research Studies)		Percentage of Research Studies Supporting the Generalization
	Supporting	*Not Supporting*	
5-11: *Stages exist in the innovation-decision process.*	13	0	100
5-12: Mass media channels are relatively more important at the knowledge stage, and interpersonal channels are relatively more important at the persuasion stage in the innovation-decision process.	18	2	90
5-13: Cosmopolite channels are relatively more important at the knowledge stage and localite channels are relatively more important at the persuasion stage in the innovation-decision process.	6	1	86
5-14: Mass media channels are relatively more important than interpersonal channels for earlier adopters than for later adopters.	8	2	80
5-15: Cosmopolite channels are relatively more important than localite channels for earlier adopters than for later adopters.	9	0	100
5-16: The rate of awareness-knowledge for an innovation is more rapid than its rate of adoption.	2	0	100
5-17: Earlier adopters have a shorter innovation-decision period than later adopters.	5	1	83

A *discontinuance* is a decision to reject an innovation after having previously adopted it. There are two types of discontinuance: (1) *replacement discontinuance,* in which an idea is rejected in order to adopt a better idea which supercedes it, and (2) *disenchantment discontinuance,* in which an idea is rejected as a result of dissatisfaction with its performance. Later adopters are more likely to discontinue innovations than are earlier adopters (Generalization 5-9). Innovations with a high rate of adoption have a low rate of discontinuance (Generalization 5-10).

We conclude on the basis of research evidence that stages exist in the innovation-decision process (Generalization 5-11). Needed in the future is *process research,* a type of data gathering and analysis that seeks to determine the time-ordered sequence of a set of events. Most past diffusion study has been *variance research,* a type of data gathering and analysis that consists of determining the covariances among a set of variables but not their time-order.

A *communication channel* is the means by which a message gets from a source to a receiver. We categorize communication channels as either interpersonal or mass media in nature, and as originating from either localite or cosmopolite sources. *Mass media channels* are all those means of transmitting messages that involve a mass medium such as radio, television, newspapers, and so on, that enable a source of one or a few individuals to reach an audience of many. *Interpersonal channels* involve a face-to-face exchange between two or more individuals.

Mass media channels are relatively more important at the knowledge stage, and interpersonal channels are relatively more important at the persuasion stage in the innovation-decision process (Generalization 5-12). Cosmopolite channels are relatively more important at the knowledge stage, and localite channels are relatively more important at the persuasion stage in the innovation-decision process (Generalization 5-13). Mass media channels are relatively more important than interpersonal channels for earlier adopters than for later adopters (Generalization 5-14). Cosmopolite channels are relatively more important than localite channels for earlier adopters than for later adopters (Generalization 5-15).

The *innovation-decision period* is the length of time required to pass through the innovation-decision process. The rate of awareness-knowledge for an innovation is more rapid than its rate of adoption (Generalization 5-16). Earlier adopters have a shorter innovation-decision period than later adopters (Generalization 5-17).

CHAPTER 6

Attributes of Innovations and Their Rate of Adoption

The reception given to a new idea is not so fortuitous and unpredictable as it sometimes appears to be. The character of the idea is itself an important determinant.

Homer G. Barnett (1953, p 313), *Innovation: The Basis of Cultural Change.*

A new medium is never an addition to an old one, nor does it leave the old one in peace. It never ceases to oppress the older media until it finds new shapes and positions for them.

Marshall McLuhan (1964), *Understanding Media.*

AMONG THE MEMBERS OF A SOCIAL SYSTEM, some innovations diffuse from first introduction to widespread use in a few years. For example, pocket calculators gained very rapid adoption during the mid-1970s. Yet another electronic innovation like home videotape equipment has only reached about 3 percent use in the past eight years. What characteristics of innovations affect the rate at which they diffuse and are adopted?

This chapter suggests five characteristics by which an innovation may be described, shows how individuals' perceptions of these characteristics predict their rate of adoption, and discusses overadoption.

When one peruses the diffusion research literature, one may be impressed with how much effort has been expended in studying "people" differences in innovativeness (that is, in determining the characteristics of the different adopter categories) and how little effort has been devoted to analyzing "innovation" differences (that is, in investigating how the properties of an innovation affect its rate of adoption). The latter type of research can be of great value to change agents seeking to predict the reactions of their clients to an innovation, and perhaps to modify certain of these reactions by the way they name and position an innovation and relate the new idea to existing beliefs.

Diffusion researchers in the past tended to regard all innovations as equivalent units from the viewpoint of study and analysis. This is an oversimplification, and a dangerous one. That all innovations are not equivalent units is evidenced by the fact that some new products fail and others succeed. The U.S. Department of Commerce estimates that 90 percent of all new products fail within four years of their release.

Attributes of Innovations

We need a standard classification scheme for describing the perceived attributes of innovations in universal terms. One would not then have to study each innovation as a special case in order to predict its rate of adoption. We could say, for example, that innovation A is more like innovation B (in the eyes of the adopters) than it is like innovation C. This general classification system is an eventual objective of diffusion research on innovation attributes. We have not reached this goal, but the present section discusses one approach that has been widely used for the past twenty years. Five different attributes of innovations will be described. Each of these is somewhat empirically interrelated with the other four, but they are conceptually distinct. Selection of these five characteristics is based on past writings and research as well as on a desire for maximum generality and succinctness. We are working toward a comprehensive set of characteristics of innovations that are as mutually exclusive and as universally relevant as possible. The five attributes of innovations are (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability. Each attribute is discussed in detail in the following sections of this chapter.

The crucial importance of perceptions in explaining human behavior was emphasized by an early sociological dictum, "If men perceive situations as real, they are real in their consequences" (Thomas and Znaniecki, 1927, p. 81). This same viewpoint was em-

phasized by Wasson (1960), who said that "The ease or difficulty of introduction [of ideas] depends basically on the nature of the 'new' in the new product—the new as the customer views the bundle of services he perceives in the newborn." It is the receivers' perceptions of the attributes of innovations, not the attributes as classified by experts or change agents, that affect their rate of adoption. Like beauty, innovations exist only in the eye of the beholder. And it is the beholder's perceptions that influence the beholder`s behavior.

Although the first research on attributes of innovations and their rate of adoption was conducted with farmers, several recent studies of teachers and school administrators suggest that similar attributes may be important in predicting the rate of adoption for educational innovations. Holloway (1977) designed his research with one hundred high school principals around the five attributes described in this chapter. General support for the present framework was found, although the distinction between relative advantage and compatibility was not very clear-cut, and the status-conferring aspects of educational innovations emerged as a sixth dimension predicting rate of adoption. Holloway (1977) factor-analyzed Likert-type scale items measuring his respondents' perceptions of new educational ideas to derive his six attributes. The method of factor analysis has similarly been used with data from teachers (Hahn, 1974; Clinton, 1973) and from farmers (Elliott, 1968; Kivlin, 1960); the results vary somewhat from study to study, but the strongest support is generally found for the attribute dimensions of relative advantage, compatibility, and complexity, with somewhat weaker support for the existence of trialability and observability.

We conclude that the most important attributes of innovations for most respondents can be subsumed under the five attributes that we use as our general framework.

The usefulnes of research on the attributes of innovations is mainly to predict *their future* rate of adoption. Most past research, however, has been *postdiction* instead *of prediction.* That is, the attributes of innovations are considered independent variables in explaining variance in the dependent variable of rate of adoption of innovations. The dependent variable is measured in the recent past, and the independent variables are measured in the present; so attributes are hardly *predictors* of the rate of adoption in past research. Generalizations, however, about such attributes as relative advantage or compatibility to explain rate of adoption have been derived from past research, and these generalizations can be used to predict the rate of adoption for innovations in the future.

Nevertheless, an ideal research design would actually measure the attributes of innovations at t_1 in order to predict the rate of adoption for these innovations at t_2 (Tornatzky and Klein, 1981). Unfortunately, the conventional repertoire of social science research methods is generally ill suited to the task of gathering data on behavior in the "here and now" to predict behavior in the "there and then." There is no perfect solution to this problem, but several research approaches are useful for helping predict into the future:

1. Extrapolation from the rate of adoption of past innovations into the future for the other innovations.
2. Describing a hypothetical innovation to its potential adopters, and determine its perceived attributes, so as to predict its rate of adoption.
3. Investigating the acceptability of an innovation in its prediffusion stages, such as when it is just being test marketed and evaluated in trials.

None of these methods of studying the attributes of innovations is an ideal means for predicting the future rate of adoption of innovations. But when they are used, especially in concert, they are better than nothing. And in any event, research on predicting an innovation's rate of adoption would be more valuable if data on the attributes of the innovation were gathered prior to, or concurrently with, individuals' decisions to adopt the innovation (Tornatzky and Klein, 1981, p. 5).*

Relative Advantage

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes. The degree of relative advantage is often expressed in economic profitability, in status giving, or in other ways. The nature of the innovation largely determines what specific type of relative advantage (such as economic, social, and the like) is important to adopters, although the characteristics of the potential adopters also affect which dimensions of relative advantage are most important (as we shall show in this section).

*Just such a research approach was used by Ostlund (1974) who gathered respondents' ratings on the perceived attributes of consumer innovations prior to their introduction on the commercial market, in order to predict the new products' rate of adoption.

Economic Factors and Rate of Adoption

Some new products involve a series of successful technological improvements that result in a reduced cost of production for the product, leading to a lower selling price to consumers. Economists call this "learning by doing" (Arrow, 1962).

A good example is the pocket calculator, which sold for about $250 in 1972; within a few years, thanks to technological improvements in the production of the semiconductors that are a vital part of the calculator, a similar (four-function) product sold for only about $10.

When the price of a new product decreases so dramatically during its diffusion process, a rapid rate of adoption is obviously facilitated. In fact, one might even question whether an innovation like the pocket calculator is really the same in 1976, when it cost $10, as in 1972 when it cost twenty-five times as much. Certainly, its absolute relative advantage has increased tremendously. Here we see an illustration of how a characteristic of an innovation changed as its rate of adoption progressed. Thus, measuring the perceived characteristics of an innovation cross-sectionally at one point in time provides only a very incomplete picture of the relationship of such characteristics to an innovation's rate of adoption. The characteristics may change as the innovation diffuses.

A controversy regarding the relative importance of profitability versus other perceived attributes of innovations for U.S. farmers can be traced through diffusion literature. Griliches (1957), an economist, explained about 30 percent of the variation in rate of adoption of hybrid corn on the basis of profitability. He used aggregate data from U.S. crop-reporting districts and states, and hence, could not claim that similar results would obtain when individual farmers were the units of analysis. Griliches (1957) concluded: "It is my belief that in the long run, and cross-sectionally, [sociological] variables tend to cancel themselves out, leaving the economic variables as the major determinants of the pattern of technological change." Griliches' strong assertion of the importance of profitability as a sole explanation of rate of adoption is consistent with the "Chicago School" of economists, who assume that, in the absence of evidence to the contrary, the market works. Market forces undoubtedly *are* of importance in explaining the rate of adoption of farm innovations. For some innovations (such as high-cost and highly profitable ideas) and for some farmers, economic aspects of relative advantage may even be

the most important single predictor of rate of adoption. But to argue that economic factors are the sole predictors of rate of adoption is ridiculous. Perhaps if Dr. Griliches had ever personally interviewed one of the Midwestern farmers whose adoption of hybrid corn he was trying to understand (instead of just statistically analyzing their aggregated behavior from secondary data sources), he would have understood that farmers are not 100 percent economic men.

Not surprisingly, rather strong evidence refuting Griliches' assertion has been brought to bear on the controversy: (1) in the case of hybrid sorghum adoption in Kansas (Brandner and Straus, 1959; Brandner, 1960; Brandner and Kearl, 1964), where compatibility was more important than profitability, and (2) for hybrid-seed corn adoption in Iowa (Havens and Rogers, 1961b; Griliches, 1962; Rogers and Havens, 1962b), where it was concluded that a combination of an innovation's profitability plus its observability were most important in determining its rate of adoption. For other commentaries in this controversy, see Griliches (1960b) and Babcock (1962). A recent reanalysis of Griliches' hybrid corn data by another economist (Dixon, 1980) led to the general conclusion that profitability and compatibility are complements, not substitutes, in explaining the rate of adoption. So the original controversy seems to have died now to a close approximation of consensus.

Status Aspects of Innovations

Undoubtedly one of the important motivations for almost any individual to adopt an innovation is the desire to gain social status. For certain innovations, such as new clothing fashions, the social prestige that the innovation conveys to its wearer is almost the sole benefit that the adopter receives. In fact, when many other members of a system have also adopted the same fashion, the innovation (such as longer skirts or designer jeans) may lose much of its social value to the adopters. This gradual loss of status giving on the part of a particular clothing innovation provides a continual pressure for yet newer fashions.

The point here is not that certain new clothing styles do not have functional utility for the wearer; for instance, jeans are an eminently practical and durable type of clothing. But certainly the main reason for buying designer jeans has more to do with the designer's name on the rear pocket, a status-conferring attribute of the innovation, than

with the durability, or utility, of the jeans. Perhaps the importance of social status in decisions to purchase new clothing is indicated by the fact that an individual's old clothing is very seldom really worn out before it is replaced by new clothes.

Clothing fashions are by no means the only class of innovations for which status-conferring considerations are a main reason for adoption, and upper-class women are by no means the only members of a population who are attracted to status-giving innovations. Generally speaking, the adoption of highly visible innovations (for instance, clothing, new cars, and hair styles) is especially likely to be status motivated. A spectacular example of the status-providing capacity of certain farm innovations is provided by the diffusion of "Harvestore" silos in the rural United States. These silos are constructed of steel and glass, painted navy blue, and prominently display the maker's name; their height dominates a farmer's skyline, so they are easily visible from public roads. Because Harvestores are so extremely expensive (from $30,000 to $70,000, depending on their size), most agricultural experts recommend that U.S. farmers buy a cheaper type of silo for storing their corn and hay sileage. But the status-conferring quality of the Harvestores appeals to many farmers. In fact, some American farmers own, and prominently display, two Harvestores, perhaps the rural equivalent of a two-car garage in a suburban home.

As we stated previously, certain individuals (who adopt an innovation at a certain time) are more highly motivated by status seeking than are others. For example, many lower-income individuals could care less about clothing fashions. In general, the middle and upper-middle class seem to exhibit a stronger concern with the status aspects of innovations. Status motivations for adoption seem to be more important for innovators, early adopters, and early majority, and less important for the late majority and laggards.

Evidence for this proposition is provided by van der Haak (1972), who interviewed two samples of Dutch small businessmen, one who had accepted financial assistance under terms of a new government program, and the other sample who had rejected such assistance (even though they were eligible for it). The adopters of government assistance were in such business enterprises as selling second-hand goods (including pawn shops); to them, the government assistance was perceived as a means of acquiring higher socioeconomic status. But the more bourgeois businessmen, who rejected the innovation of government assistance, perceived it as shameful to accept; they felt

they would threaten their social prestige in the eyes of the local community if they accepted the disgrace of government help, even though they needed it. So the striving toward social status was strong for both the adopters and rejecters, but government assistance as an innovation had a totally different social meaning for each of the two groups. Social status motivations were more important than economic need for the Dutch small businessmen who decided to reject this innovation.

We believe that the status motivations for adopting innovations have been understudied in past diffusion research. This may be due in part to the reluctance of respondents to admit that they adopted a new idea in order to secure the status aspects associated with the innovation. Direct questioning of adopters about this motivation is likely to underestimate its real importance in adoption decisions. Perhaps improved measurement approaches to investigating different motivations for adopting an innovation are needed.

Certainly it is not safe to assume, as it often has been in the past, that economic dimensions of relative advantage are the only predictors of rate of adoption. Even though every innovation is judged on economic grounds to a certain degree (by its potential adopters), every innovation also has some degree of status conferral.

Relative Advantage and Rate of Adoption

Throughout this book we have emphasized that the diffusion of an innovation is an uncertainty-reduction process. When individuals (or an organization) pass through the innovation-decision process, they are motivated to seek information in order to decrease uncertainty about the relative advantage of an innovation. Potential adopters want to know the degree to which a new idea is better than an existing practice. So relative advantage is often the content of the network messages about an innovation. The exchange of such innovation-evaluation information lies at the heart of the diffusion process.

Given this, it is not surprising that diffusion scholars have found relative advantage to be one of the best predictors of an innovation's rate of adoption. Relative advantage, in one sense, indicates the strength of the reward or punishment resulting from adoption of an innovation. There are a number of subdimensions of relative advantage: the degree of economic profitability, low initial cost, a decrease in discomfort, a savings in time and effort, and the immediacy of the

reward. This latter factor explains in part why preventive innovations have an especially low rate of adoption. *A preventive innovation* is a new idea that an individual adopts in order to avoid the possibility of some unwanted future event. Such ideas as buying insurance, using auto seat belts, adopting soil-conservation practices, getting innoculations against disease, and adopting contraceptive methods are examples. The relative advantage of preventive innovations is difficult for change agents to demonstrate to their clients, because it occurs at some future, unknown time.*

A summary of investigations of perceived attributes of innovations and their rate of adoption is shown in Table 6-1. Almost every one of these studies reports a positive relationship between relative advantage and rate of adoption.

We may summarize these research findings on relative advantage with Generalization 6-1: *The relative advantage of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.* Unfortunately, for purposes of generalizability, the respondents in most of these studies are U.S. commercial farmers, and their motivation for adoption of these innovations is centered on economic aspects of relative advantage. As Fliegel and Kivlin (1966a) point out: "Since we are dealing here with innovations having direct economic significance for the acceptor, it is not surprising that innovations perceived as most rewarding and involving least risk and uncertainty should be accepted most rapidly." In fact, a study by Kivlin and Fliegel (1967a) that includes U.S. small-scale farmers (who are oriented less to profit considerations) finds that a decrease in discomfort, one subdimension of relative advantage, but not economic profitability, is positively related to rate of adoption.

Economic aspects of relative advantage may be even less important for peasants in developing nations. In fact, Fliegel and others (1968) found that Punjab farmers in India behaved more like small-scale Pennsylvania farmers (actually, even more so) than like large-scale U.S. farmers, regarding their perceptions of innovations: "Much more than financial incentives will be necessary to obtain widespread and rapid adoption of improved practices. . . . Unlike the Pennsylvania dairy farmers, the Punjabi respondents apparently attach greater importance to social approval and less to financial return" (Fliegel et al, 1968).

*A lack of observability is also a characteristic of preventive innovations that slows their rate of adoption.

Effects of Incentives

Many change agencies award incentives or subsidies to clients in order to speed the rate of adoption of innovations. One function of an incentive for adopters is to increase the degree of relative advantage of the new idea. *Incentives* are direct or indirect payments of cash or in kind that are given to an individual or a system in order to encourage some overt behavioral change. Often, the change entails the adoption of an innovation.

Incentives have been paid in order to speed up the diffusion of innovations in a variety of fields: agriculture, health, medicine, and family planning. More research has undoubtedly been conducted on family-planning incentives than in any other field. Actually, there are many different forms that incentives can take (Rogers, 1973, pp. 157-159):

1. *Adopter versus diffuser incentives.* Incentives may be paid either directly to an adopter, or to another individual to encourage him or her to persuade an adopter. An illustration of a diffuser incentive is that paid to vasectomy canvassers in India (described in Chapter 9). A diffuser incentive increases the observability of an innovation, rather than its relative advantage.

2. *Individual versus system incentives.* Payments may be paid to individual adopters or change agents, or to social systems to which they belong. For example, the government family-planning agency in Indonesia pays a community incentive to villages that achieve a high rate of adoption of contraceptives; such an incentive policy increases the relative advantage of birth control.

3. *Positive versus negative incentives.* Most incentives are positive in that they reward a desired behavior change (like adoption of a new idea), but it is also possible to penalize an individual by imposing an unwanted penalty or by withdrawing some desiderata for not adopting an innovation. For example, the government of Singapore has decreed that any family that has a third (or further) child is not eligible to receive maternity leave and must pay all hospital and delivery costs (which are otherwise free to all citizens).

4. *Monetary versus nonmonetary incentives.* While incentives are often financial payments, they may also take the form of some commodity or object that is desired by the recipient. For instance, in one state in India a sari with red triangles (the symbol of family planning in India) was awarded to each woman who was sterilized.

Table 6-1. Perceived Attributes of Innovations and Their Rate of Adoption.

Author(s) of Investigations	Type of Respondents	Number of Innovations Studied	Number of Attributes of Innovations Measured	Percentage of Variance in Rate of Adoption Explained	Attributes of Innovations Found to be Significantly Related to Rate of Adoption
1. Kivlin (1960); Fliegel and Kivlin (1962).	229 Pennsylvania farmers	43	11	51	(1) Relative advantage (2) Compatibility (3) Complexity
2. Tucker (1961)	88 Ohio farmers	13	6	—	None
3. Mansfield (1961)	Coal, steel, brewing, and railroad firms	12	2	50	(1) Relative advantage (profitability) (2) Observability (rate of interaction about the innovation among the adopters)
4. Fliegel and Kivlin (1966a)	229 Pennsylvania farmers*	33	15	51	(1) Trialability (2) Relative advantage (initial cost)
5. Petrini (1966)	1,845 Swedish farmers	14	2	71	(1) Relative advantage (2) Complexity
6. Singh (1966)	130 Canadian farmers	22	10	87	(1) Relative advantage (rate of cost recovery, financial return, and low initial cost) (2) Complexity (3) Trialability (4) Observability
7. Kivlin and Fliegel (1967a); Kivlin and Fliegel (1967b)	80 small-scale Pennsylvania farmers (and 229 large-scale farmers)	33	15	51	(1) Relative advantage (savings of discomfort)
8. Fliegel et al (1968)	387 Indian peasants	50	12	58	(1) Relative advantage (social approval, continuing cost, and time-saving) (2) Observability (clarity of results)
	80 small-scale Pennsylvania farmers†	33	12	62	(1) Relative advantage (savings of discomfort, payoff, and time saving)
	229 large-scale Pennsylvania farmers‡	33	12	49	(1) Trialability (2) Relative advantage (initial cost)
9. Clinton (1973)	383 elementary school teachers in Canada	18	16	55	(1) Relative advantage (including cost) (2) Complexity (3) Compatibility (4) Observability
10. Hahn (1974)	209 U.S. teachers	22	5+	—	(1) Observability (2) Complexity (3) Compatibility
11. Holloway (1977)	100 high-school principals	1	5+	—	(1) Relative advantage and compatibility (2) Complexity (3) Trialability (4) Observability
12. Allan and Wolf (1978)	100 school staff members	—	5	—	(1) Complexity

*The same 229 Pennsylvania farmers are involved in this study as in Kivlin (1960) above, but 33 instead of 43 innovations, and 15 instead of 11 attributes, were analyzed. Hence, the results are different.

†These are the same 80 small-scale Pennsylvania farmers as in Kivlin and Fliegel (1967a), but 12 instead of 15 attributes are included in the multiple-correlation prediction of rate of adoption; the results obtained are therefore different.

‡These are the 229 large-scale Pennsylvania farmers in Kivlin (1960) above, but a different number of innovations and attributes are included in the analysis; hence, the results are different.

5. *Immediate versus delayed incentives.* Most incentives are paid at the time of adoption, but others can only be awarded at a later time. For example, some developing nations provide a cost-free education for the children of a couple who have a small family.

Any combination of these five types of incentive policies can be paid in any given situation. Gradually, evidence is being accumulated as to which particular combination has a desired influence on the diffusion of innovation. As such, incentives offer one diffusion strategy that affects the perceived attributes of innovations, especially relative advantage, and thus an innovation's rate of adoption. Some incentive policies are designed only to encourage trial of a new idea; an illustration is the free samples of a new product that many commercial companies offer to their customers. The strategy here is that by facilitating trial use, full-scale adoption will follow (if the innovation possesses a potential relative advantage that can be perceived by the receiver). Other incentive policies are designed only to secure adoption of a new idea by earlier adopters; once a level of 20 or 30 percent adoption is reached in a social system, the economic incentive is discontinued by the change agency. For example, the federal and several state governments offer tax-rebate incentives for the adoption of residential solar heating. But the cost of such incentives would become too large to be acceptable, once a level of 5 or 10 percent adoption is reached. So they are just pump-priming incentives, intended to launch the diffusion process.

On the basis of research and experience with family planning innovations, Rogers (1973, pp. 159-174) draws the following conclusions.

1. *Incentives increase the rate of adoption of an innovation.* Adopter incentives increase relative advantage, and diffuser incentives increase the communicability with which an innovation is perceived. Further, an adopter incentive can act as a *cue-to-action* (an event occurring at a point in time that crystallizes a favorable attitude into overt behavior change) in triggering the adoption of an innovation.

2. *Adopter incentives lead to adoption of an innovation by individuals different from those who would otherwise adopt.* Innovators and early adopters usually have higher socioeconomic status and other characteristics that set them off from later adopters (Chapter 7). But when a large adopter incentive is paid to family planning accepters, individuals of *lowest* socioeconomic status seem to be most innovative.

3. *Although incentives increase the quantity of adopters of an innovation, the quality of such adoption decisions may be relatively low, leading to limitations in the intended consequences of adoption.* If individuals adopt an innovation partly in order to obtain an incentive, there is relatively less motivation to continue using the innovation (if it can be discontinued).

There are serious ethical aspects involved in paying incentives. But the design of incentive policies can be improved by empirical studies that evaluate the effects of incentives on the rate of adoption, continuation, and consequences of innovations.

Compatibility

Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. An idea that is more compatible is less uncertain to the potential adopter. An innovation can be compatible or incompatible (1) with sociocultural values and beliefs, (2) with previously introduced ideas, or (3) with client needs for innovations.

Compatibility with Values and Beliefs

Many illustrations can be provided of how the incompatibility of an innovation with cultural values blocks its adoption. We cited, in Chapter 1, how the residents in the Peruvian village of Los Molinos perceived water boiling as incompatible with their cultural values on the hot-cold classification. American farmers place a strong value on increasing farm production; soil-conservation innovations are percieved as conflicting with this production value, and have generally been adopted very slowly.

In modern urban India there is a strong norm against eating food with the left hand, which is believed to be unclean. This habit began in past centuries when Indian villagers used their left hand for certain functions associated with defecation. At that time there were inadequate washing and sanitary facilities and the left-hand-as-unclean complex was functional. But today it is easy for urban, middle-class Indians to wash their hands before meals. Nevertheless, the unclean-hand habit rigidly persists as an element in urban India. How would

you like to *be* the change agent who is responsible for persuading Indians to eat with their left hands? Many change agents face equally difficult assignments in promoting innovations that run counter to strongly held values.

Compatibility with Previously Introduced Ideas

An innovation may be compatible not only with deeply imbedded cultural values but also with previously adopted ideas. Compatibility of an innovation with a preceding idea can either speed up or retard its rate of adoption. Old ideas are the main tools with which new ideas are assessed. One cannot deal with an innovation except on the basis of the familiar and the old fashioned. Previous practice is a familiar standard against which the innovation can be interpreted, thus decreasing uncertainty.

Examples of the use of past experience to judge new ideas come from a diffusion study in a Colombian peasant community (Fals Borda, 1960). At first, farmers applied chemical fertilizers on top of their potato seed (as they had done with cattle manure), thereby damaging their seed and causing a negative evaluation of the innovation. Other peasants excessively sprayed their potatoes with insecticides, transferring to the new idea their old methods of watering their plants.

Hawley (1946) sought to determine why the Roman Catholic religion, as offered by proselytizing Spanish priests, was readily accepted by Eastern Pueblo Indians in Arizona and New Mexico, whereas the Western Pueblos, "after a brief taste of Catholicism, rejected it forcefully, killed the priests, burned the missions, and even annihilated the village of Awatobi when its inhabitants showed a tendency to accept the acculturation so ardently proffered." Hawley concluded that the Eastern Pueblos, whose family structure was heavily patrilineal and father oriented, were attracted by a new religion in which the deity was a male figure. Catholicism, however, was incompatible with the mother-centered beliefs of the Western Pueblos. Perhaps if the change agents had been able to emphasize the female-image aspect of Catholicism (the Virgin Mary), they would have achieved greater success among the Western Pueblo tribes.

The rate of adoption of a new idea is affected by the old idea that it supersedes. Obviously, however, if a new idea were completely congruent with existing practice, there would be no innovation, at least in the mind of the potential adopters.* In other words, the more compatible an innovation is, the less of a change it represents. How useful, then, is the introduction of a very highly compatible innovation? Quite useful, perhaps, if the compatible innovation is seen as the first step in a series of innovations that are to be introduced sequentially. The compatible innovation paves the way for later, less compatible innovations.

A negative experience with one innovation can damn the adoption of future innovations. Such innovation negativism (Arensberg and Niehoff, 1964) is an undesirable aspect of compatibility. *Innovation negativism* is the degree to which an innovation's failure conditions a potential adopter to reject future innovations. When one idea fails, potential adopters are conditioned to view all future innovations with apprehension.

Compatibility with Needs

One indication of the compatibility of an innovation is the degree to which it meets a need felt by the clients. Change agents seek to determine the needs of their clients, and then recommend innovations to fulfill these needs. The difficulty often lies in how to feel felt needs; change agents must have a high degree of empathy and rapport with their clients in order to assess their needs accurately. Informal probing in interpersonal contacts with individual clients, client advisory committees to change agencies, and surveys are sometimes used to determine needs for innovations.

Clients may not recognize that they have needs for an innovation until they are aware of the new idea or of its consequences. In these cases, change agents may seek to generate needs among their clients but this must be done carefully or else the felt needs upon which diffusion campaigns are based may be only a reflection of the change agent's needs, rather than those of his clients. Therefore, one dimension of compatibility is the degree to which an innovation is perceived

*Just such a case is reported by Hahn (1974), who found that the U.S. social studies teachers he studied rejected educational innovations that were too similar to existing practices. If an innovation is too similar, it appears to offer no advantage over the status quo.

as meeting the needs of the client system. When felt needs are met, a faster rate of adoption usually occurs.

Compatibility and Rate of Adoption

The examples just reviewed, and other evidence, support Generalization 6-2: *The compatibility of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.* Statistical analyses of this proposition, which control the effects of other attributes of innovations (Table 6-1), show compatibility to be of relatively less importance in predicting rate of adoption than other attributes, such as relative advantage. This result may be in part an artifact of difficulties in measuring perceived compatibility. In most of the studies shown in Table 6-1, compatibility was found to be positively related to rate of adoption, even though the correlation was often not significant when the effects of other attributes were removed statistically.

Technology Clusters

Innovations often are not viewed singularly by individuals. They may be perceived as an interrelated bundle of new ideas. The adoption of one new idea may trigger the adoption of several others.

A *technology cluster* consists of one or more distinguishable elements of technology that are perceived as being closely interrelated. The boundaries around any given innovation are often not very clear-cut or distinct. In the minds of potential adopters, one innovation may be perceived as closely related to another new idea. If this is the case, a change agency might find it useful to promote a cluster or package of innovations to clients, rather than to treat each new idea separately.

For instance, in India and other developing nations, a package of agricultural innovations, usually including improved crop varieties, fertilizer, and other agricultural chemicals, is recommended in toto to farmers. Experience indicates that villagers adopt the package more easily and rapidly than they would adopt if each of the innovations had been diffused individually. More importantly, by adopting all at once, farmers get the total yield effects of all the innovations, plus the interaction effects of each practice on the others.

Unfortunately, the package approach has little empirical basis in

diffusion research even though it may seem to make sense intuitively. Naturally, the packaging should be based on the user's *perceptions* of the innovations, but this has not been done. Factor analysis of the intercorrelations among adopters' time of adoption (or their perceptions) of a series of innovations can be used to determine which of the innovations cluster together, as Crouch (1981) demonstrated for Australian sheep farmers.

One of the few investigations of a complex of new ideas is Silverman and Bailey's (1961) analysis of the adoption of three corn-growing innovations by 107 Mississippi farmers. The three ideas (fertilization, hybrid-seed, and thicker planting) were functionally interrelated in such a way that adoption of the latter innovation without concurrent use of the other two ideas resulted in *lower* corn yields than if none of the ideas was used. Most farmers either adopted all three of the ideas or none of them, but 8 percent used unsuccessful combinations. Silverman and Bailey suggest the need for change agents to show farmers the interrelationships among the three ideas in the corn-growing complex.

Some merchandisers offer tie-in sales, a technique that recognizes the high degree of compatibility among several new products. A new clothes washer may be offered to housewives as a package deal along with a dryer. Some marketing schemes "hook on" an unwanted product to a compatible innovation that possesses a high degree of relative advantage.

There is need to analyze complexes of innovations in future research, to study new ideas in an evolutionary sequence, and to determine the degree of compatibility perceived by individuals among interrelated ideas. We would then have a sounder basis for the assembling of innovations in easier-to-adopt packages.

Naming an Innovation

The name given to an innovation often affects its compatibility, and therefore its rate of adoption. Not enough attention has been paid to what innovations are called by potential adopters, and as a result many serious mistakes have been made. For instance, a major U.S. soap company introduced its trademarked product "Cue" into French-speaking nations, where the word has an obscene connotation. Such egregious errors have shown commercial companies the importance of market research to pretest the name for a new product

prior to its release. On the other hand, public change agencies generally do not *realize* the importance of what an innovation is called.

The perception of an innovation is colored by the word-symbols used to refer to it. The selection of an innovation's name is a delicate and important matter. Words are the thought units that structure our perceptions. And of course it is the potential adopters' perceptions of an innovation's name that affect its rate of adoption. Sometimes a medical or a chemical name is used for an innovation that comes from medical or chemical research and development; unfortunately, such names are not very meaningful to potential adopters (unless they are physicians or chemists). Examples are "2,4-D weed spray," "IR-20 rice variety," and "intrauterine device," terms that were confusing and misunderstood by farmers or family planning adopters. A new intrauterine device, the "copper-T," was introduced in South Korea without careful consideration of an appropriate Korean name. The letter "T" does not exist in the Korean alphabet, and copper is considered a very base metal and has a very unfavorable perception. Thus, one could hardly have chosen a worse name (Harding et al, 1973).

In contrast, the word "Nirodh" was carefully chosen in India in 1970 as the most appropriate term for condoms. Prior to this time, condoms had a very negative perception as a contraceptive method; they were thought of mainly as a means of preventing venereal disease. When the government of India decided to promote condoms as a contraceptive method, they pretested a variety of terms. "Nirodh," a Sanskritic word meaning "protection," was selected, and then promoted in a huge advertising campaign to the intended audience (Rogers, 1973, p. 237). The result was a sharp increase in the rate of adoption of "Nirodhs."*

We recommend such a receiver-oriented, empirical approach to naming an innovation, so that a word-symbol that has the desired meaning to the audience is chosen.

Positioning an Innovation

A basic assumption of positioning research is that an individual will behave toward a new idea in a manner that is similar to the way he or she behaves toward other ideas that the individual perceives as similar to the new idea. For instance, consider a category of existing products consisting of products *A, B,* and *C.* If a new product, *X,* is introduced to the audience for these products, and if they perceive X as similar to *B,* but unlike *A* and *C,* then consumers who bought *B* will be just as likely to buy *X* as *B.* If other factors (like price) are equal, X should attain about one-half of the former *B* consumers, but the introduction of *X* should not affect the sales of products *A* and C. Further, if we can learn why consumers perceive *B* and *X* as similar, but different from *A* and *C, X can* be positioned (through its name, color, packaging, taste, and the like) so as to maximize its distance *from A, B,* and C in the minds of consumers, and thus to gain a unique niche for the new idea.

Obviously, the positioning of an innovation rests on accurately measuring its compatibility with previous ideas.

Research to position new products is often conducted by market researchers, and many of the methods for positioning an innovation have been developed by commercial researchers. But these positioning techniques can be used to ease the introduction of any type of innovation. For instance, Harding et al (1973, p. 21) used positioning methods to introduce the copper-T, a new intrauterine device in Korea. First, they asked a small sample of potential adopters to help identify twenty-nine perceived attributes of eighteen contraceptive methods in an open-ended, unstructured approach. Then another sample of Korean respondents were asked to rate each of the eighteen family planning methods (including the copper-T, the only new method) on these thirty-nine attributes (which included numerous subdimensions of the five main attributes discussed in this chapter). The result was a series of recommendations about which attributes of the copper-T should be stressed in its diffusion campaign, in order to maximize its rate of adoption. For instance, Harding et al (1973, p. 10) recommended stressing the copper-T's long lifetime, its reliability (in preventing unwanted pregnancies), its lack of interference with sexual life, and its newness. These researchers also recommended a change in the physical nature of the copper-T: "Certain features of the copper-T, such as the string [a plastic thread used to remove the intrauterine device], perhaps should be altered since the string is associated with causing bacteria to enter the womb and with causing an inflammation of the womb" (Harding et al, 1973, p. 11).

Positioning research, thus, can help identify an ideal niche for an innovation to fill relative to existing ideas in the same field. This ideal niche is determined on the basis of the new idea's position (in the

*In part, because use of the word "Nirodh" helped overcome the tabooness of condoms. *Taboo communication* is a type of message transfer in which the messages are perceived as extremely private and personal in nature because they deal with proscribed behavior.

perceptions of potential adopters) relative (1) to previous ideas, and (2) to the characteristics of the new idea that make it similar to, and different from, existing ideas. The positioning approach views an innovation's perceived characteristics (at least some of them) as changeable.

Positioning research puts the diffusion researcher in the role of designer (or at least co-designer) of innovations.

One special kind of positioning research is that conducted in order to provide guidance to R&D activities on what kind of innovations to produce. The logic here is that if innovations of type *X* will not be accepted by potential adopters but innovations of type *Y* will be accepted, R&D workers should concentrate their efforts to develop type *Y* innovations. An example of this approach is provided by the World Health Organization's (WHO) Human Reproduction Unit in Geneva, which directs a worldwide program of research on contraceptives for use in developing nations. In the past, most contraceptive methods have faced difficult problems of acceptability (Rogers, 1973). So WHO conducts diffusion studies of what types of contraceptives would be accepted if they were available. These recommendations are then used to give directions to WHO biomedical researchers to create a new contraceptive with an "ideal" set of attributes.

For example, diffusion studies on contraceptives show that men and women in developing nations are very adverse to using a birth control method that requires manipulation of human genitals. Unfortunately, the main contraceptives promoted by government family planning programs in developing nations in the 1960s and 1970s required genital manipulation: the intrauterine device, condoms, and the diaphragm, for instance. Perhaps the lack of compatibility of these contraceptive methods with the value against genital handling is one reason why their rate of adoption has been generally discouraging. Future WHO biomedical research has been directed, in part, toward developing contraceptives that do not require genital handling, for example, an injectable contraceptive (Rogers and Pareek, 1982).

Complexity

Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use. Any new idea may be classified on the complexity-simplicity continuum. Some innovations are clear in their meaning to potential adopters while others are not. Although the research evidence is far from conclusive, we suggest Generalization 6-3: *The complexity of an innovation, as perceived by members of a social system, is negatively related to its rate of adoption.*

Kivlin (1960) found that the complexity of farm innovations was more highly related (in a negative direction) to their rate of adoption than any other characteristic of the innovations except relative advantage. Similar results were reported by Singh (1966) in Canada and by Petrini (1966) in Sweden (Table 6-1).

Graham (1956) sought to determine why canasta and television diffused at different adoption rates among the upper and lower socioeconomic classes. One reason was the difference in complexity of the two ideas. Canasta had to be learned through detailed personal explanation from other card players. Its procedures were complex and difficult to master. Television, however, appeared to be a relatively simple idea that required only the ability to turn a knob.

Trialability

Trialability is the degree to which an innovation may be experimented with on a limited basis. New ideas that can be tried on the installment plan will generally be adopted more rapidly than innovations that are not divisible. An innovation that is trialable is less uncertain for the adopter. Some innovations are more difficult to divide for trial than others. In spite of the lack of strong evidence, we suggest Generalization 6-4: *The trialability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.* Studies by Fliegel and Kivlin (1966a), Singh (1966), and Fliegel et al (1968) support this statement (Table 6-1).

Relatively earlier adopters perceive trialability as more important than do later adopters (Gross, 1942; Ryan, 1948). Laggards move from initial trial to full-scale use more rapidly than do innovators and early adopters. The more innovative individuals have no precedent to follow when they adopt, while the later adopters are surrounded by peers who have already adopted the innovation. These peers may act as a psychological or vicarious trial for the later adopters, and hence, the actual trial of a new idea is of less significance for them.

Observability

Observability is the degree to which the results of an innovation are visible to others. The results of some ideas are easily observed and communicated to others, whereas some innovations are difficult to describe to others. We suggest Generalization 6-5: *The observability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.*

Most of the innovations studied in diffusion research are technological ideas. A *technology* is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome. A technology has two components: (1) a *hardware* aspect that consists of the tool that embodies, the technology as material or physical objects, and (2) a *software* aspect that consists of the information base for the tool. An example, cited in Chapter 1, is computer hardware (the equipment) and software (the computer programs). Usually the software component of a technological innovation is not so apparent to observation, so innovations in which the software aspect is dominant possess less observability, and usually have relatively slower rates of adoption.

Explaining Rate of Adoption

Rate of adoption is the relative speed with which an innovation is adopted by members of a social system. It is generally measured as the number of individuals who adopt a new idea in a specified period. So rate of adoption is a numerical indicant of the steepness of the adoption curve for an innovation.

We showed previously in this chapter that one important type of variable in explaining the rate of adoption of an innovation is its perceived attributes. Table 6-1 indicated that 49 to 87 percent of the variance in rate of adoption is explained by the five attributes (relative advantage, compatibility, complexity, trialability, and observability). In addition to these perceived attributes of an innovation, such other variables as (1) the type of innovation-decision, (2) the nature of communication channels diffusing the innovation at various stages in the innovation-decision process, (3) the nature of the social system, and (4) the extent of change agents' promotion efforts in diffusing the innovation, affect an innovation's rate of adoption (Figure 6-1).

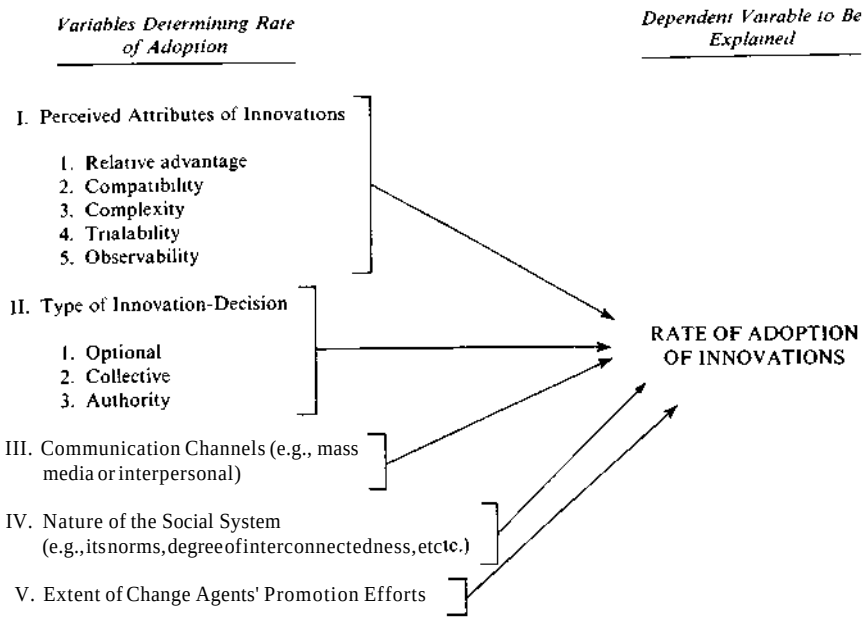

Figure 6-1. A paradigm of variables determining the rate of adoption of innovations.

The type of innovation-decision is related to an innovation's rate of adoption. We generally expect that innovations requiring an individual-optional innovation-decision will be adopted more rapidly than when an innovation is adopted by an organization (Chapter 10). The more persons involved in making an innovation-decision, the slower the rate of adoption. If so, one route to speeding the rate of adoption is to attempt to alter, the unit of decision so that fewer individuals are involved. For instance, it has been found in the United States that when the decision to adopt fluoridation of municipal water supplies is made by a mayor or city manager, the rate of adoption is quicker than when the decision is made collectively by a public referendum.

The communication channels used to diffuse an innovation also may have an influence on the innovation's rate of adoption (Figure 6-1). For example, if interpersonal channels must be used to create awareness-knowledge, as frequently occurs among later adopters, the rate of adoption will be slowed.

The relationship between communication channels and rate of adoption are even more complicated than Figure 6-1 suggests. The attributes of the innovation and the communication channels probably

interact to yield a slower or faster rate of adoption. For example, Petrini et al (1968) found differences in communication-channel use on the basis of the perceived complexity of innovations among Swedish farmers. Mass media channels, such as agricultural magazines, were satisfactory for less complex innovations, but interpersonal contact with extension change agents was more important for innovations that were perceived by farmers as more complex. And if an inappropriate channel was used, such as mass media channels, for complex ideas, a slower rate of adoption resulted.

There is also a further consideration (see Figure 6-1): the nature of the social system. Especially important are the norms of the system and the degree to which communication network structure displays a high degree of interconnectedness, as we discuss in the following section on the diffusion effect.

Last, as suggested by Figure 6-1, an innovation's rate of adoption is affected by the extent of change agents' promotion efforts. The relationship between rate of adoption and change agents' efforts, however, is not usually direct and linear. There is a greater pay-off from a given amount of change agent activity at certain stages in an innovation's diffusion. Stone (1952) and Petrini (1966) show that the greatest response to change agent effort occurs when opinion leaders are adopting, which usually occurs somewhere between 3 and 16 percent adoption in most systems.

As yet, there has been very little diffusion research designed to determine the relative contribution of each of the five types of variables (shown in Figure 6-1).

The Diffusion Effect

Not only does change agent effort have a different effect at different points in the sequence of an innovation's rate of adoption, but the system's self-generated pressures toward adoption also change as an increasing proportion of the members of the system adopt. We term this increasing pressure from interpersonal networks the "diffusion effect."

The *diffusion effect* is the cumulatively increasing degree of influence upon an individual to adopt or reject an innovation, resulting from the activation of peer networks about an innovation in a social system. For example, when only 5 percent of the individuals in a system are aware of a new idea, the degree of influence upon an individual to adopt or reject the innovation is quite different from when 95 percent have adopted. In other words, the norms of the system toward the innovation change over time as the diffusion process proceeds, and the new idea is gradually incorporated into the lifestream of the system. The communication environment of the system regarding the innovation changes as increasing numbers of individuals in the system adopt.

There is a complex but important interrelationship between the rate of knowledge about an innovation in a system and its rate of adoption. In one sense, the level of knowledge at any given time is an indication of the total amount of information about the innovation available to the average individual in the system. When such a level of information (and accompanying network influence) is very low, adoption of the innovation is unlikely for any given individual. As the level of innovation-evaluation information increases past a certain threshold, adoption is more likely to occur as the self-generated network pressures toward adoption increase. This relationship is positive but not linear and direct. As the rate of awareness-knowledge of the innovation increases up to about 20 to 30 percent, there is very little adoption. Then, once this threshold point is passed, each additional percentage of awareness-knowledge in the system is usually associated with several percentage increases in the rate of adoption. The diffusion effect means that until an individual has a certain minimum level of information and peer influence from his or her system's environment, he or she is unlikely to adopt. But once this threshold is passed (the exact threshold point is different for every innovation and every system), adoption of the idea is further increased by each additional input of knowledge and influence to the system's communication environment. A threshold seems to occur at about the point where the opinion leaders in a system begin to favor the innovation.

An Investigation of the rate of adoption of five food innovations among 1,028 housewives in five Guatemalan villages provides some further evidence of the importance of the diffusion effect in explaining adoption rates (Mendez, 1968). Faster rates of adoption were found in more highly interconnected villages where there was more network interaction among the villagers and where more of them were reached by interpersonal networks. Supporting evidence is provided by Guimaraes (1968), Yadav (1967), Coughenour (1964), and Coleman et al (1966). In all cases it seems that social systems whose members are more closely linked by communication networks have a

stronger diffusion effect and a faster rate of adoption of innovations. We conclude this discussion with Generalization 6-6: *The degree of interconnectedness in a social system is positively related to the rate of adoption of innovations.*

An elsewhere in this book, we see how subjective evaluation of an innovation, conveyed by interpersonal networks, drives the diffusion process.

Overadoption

Overadoption is the adoption of an innovation by an individual when experts feel that he or she should reject. There are several possible reasons for Overadoption, including insufficient knowledge about the new idea on the part of the adopter, an inability to predict its consequences, and/or the status-conferring aspect of a new idea. The general point is that certain individuals have such a penchant for anything that is new that they occasionally appear to be suckers for change.

It is often difficult to determine whether an individual should or should not adopt an innovation. *Rationality,* defined as the use of the most effective means to reach a given goal, is not easily measurable. The classification can sometimes be made by an expert on the innovation under study. In one sense, most individuals perceive their actions to be rational. Through lack of knowledge or through inaccurate perceptions, the individual's evaluation of an innovation may not agree with the expert's. Our main concern is with objective rationality in the present case, rather than with subjective rationality as perceived by the individual.

The idea of Overadoption implies that one role of the change agent is to prevent "too much" adoption of an innovation, as well as to try to speed up the diffusion process. In many fields Overadoption is a major problem. Elsewhere we mentioned the adoption of Harvestore silos by American farmers, an innovation that is not recommended by agricultural experts. In the field of medicine, expensive equipment is sometimes purchased whose use cannot be justified. For example, Scannel et al (1971) indicated that there were at least twice as many establishments for open-heart surgery in the United States as were needed. As a result, many of the surgical teams were not operating frequently enough to keep their skills at a safe level of performance.

The CAT Scanner: Technology Run Wild?

A well-known illustration of Overadoption is the CAT (computerized axial tomography) scanner. This technology builds upon the principle of x-rays, which lose energy when they pass through more dense objects (such as bone), thus leaving a darker image on the x-ray photograph. The CAT scanner builds on this principle by indicating the exact amount of energy absorbed by an object from a number of different angles, processing this information in a computer, and reconstructing it on a television screen. The CAT scanner is a major improvement over x-rays, and its British co-inventors were awarded the Nobel Prize in physiology and medicine. The technology is expensive; each CAT scanner costs over half a million, and each individual workup costs from 450 to 500 dollars in private clinics and about half this amount in public medical facilities.

Banta (1980) and Shell (1981) estimate the rate of adoption of CAT scanners in the United States as:

Year	*Cumulative Number of CAT Scanners*
1973	6
1974	45
1975	202
1976	475
1977	901
1978	1,042
1979	1,248
1980	1,471

This rapid diffusion, the high cost of the equipment, and a concern that the CAT scanner might be overutilized, led to several assessments of this innovation by federal agencies. For instance, the Congressional Office of Technology Assessment (OTA) concluded: "The development and diffusion of CAT scanners occurred without formal and detailed proof of their safety and efficacy" (Shell, 1981). Further, David Banta (1980), Director of Health Programs for OTA, argued that "federal policies designed to slow diffusion or to assure optimal placement or wise use of scanners have not had demonstrable effects." Banta shows that a disproportionate number of CAT scanners are found in wealthy areas like Beverly Hills, New York City's Upper East Side, and West Palm Beach while rural and low-income areas are unlikely to be served by a CAT scanner (Banta, 1980). Some hospitals may adopt a CAT scanner in order to enhance their status (Shell, 1981). A good part of the high cost of the CAT scanner can be obtained by a local adopter from federal government health agencies, through their reimbursement of patient fees. Unfortunately, one ef-

fect of medical innovations like the CAT scanner is that they can drive up the cost of medical care to the American public. Some critics charge that the CAT scanner was not properly evaluated by the U.S. government prior to its diffusion. Further, federal policies designed to slow the rate of adoption and to assure proper distribution of equipment and its wise use have not been very effective (Banta, 1980). Nevertheless, a 1981 conference on CAT scanners sponsored by the National Institutes of Health concluded that some hospitals in major cities still do not have a CAT scanner. This meeting, however, was mainly concerned about the possible overuse of CAT scans with small children where repeated doses of such low-level radiation might have ill effects.

In summary, Banta (1980) claims this case of overadoption exemplifies the problem of "technology run wild." As we have seen, however, the case is much more complicated, with the distribution of the CAT scanner as much a problem as its overadoption.

Summary

This chapter suggested five attributes of innovations by which an innovation can be described, and showed that individuals' perceptions of these characteristics are predictive of the rate of adoption. We emphasize that it is the receiver's perceptions of innovations' attributes that affect their rate of adoption (Table 6-2).*

Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. The relative advantage of an innovation, as perceived by members of a social system, is positively related to its rate of adoption (Generalization 6-1).

Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters. The compatibility of an innovation, as perceived by members of a social system, is positively related to its rate of adoption (Generalization 6-2).

Complexity is the degree to which an innovation is perceived as relatively difficult to understand and to use. The complexity of an innovation, as perceived by members of a social system, is negatively related to its rate of adoption (Generalization 6-3).

Trialability is the degree to which an innovation may be experimented with on a limited basis. The trialability of an innovation,

* Our synthesis of the research evidence supporting the generalizations in this chapter (Table 6-2) generally agrees with the results of a recent meta-research of seventy-five research studies by Tornatzky and Klein (1981); they found the strongest support for the relationships of relative advantage, compatibility, and complexity with rate of adoption, and less support for trialability and observability.

Table 6-2. A Summary of the Research Evidence Supporting and Not Supporting Generalizations about the Rate of Adoption of Innovations.

Generalization	Support of the Generalization (Number of Research Studies)		Percentage of Research Studies Supporting the Generalization
	Supporting	*Not Supporting*	
6-1: The relative advantage of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.	29	14	67
6-2: The compatibility of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.	18	9	67
6-3: The complexity of an innovation, as perceived by members of a social system, is negatively related to its rate of adoption.	9	7	56
6-4: The trialability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.	9	4	69
6-5: The observability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption.	7	2	78
6-6: The degree of interconnectedness in a social system is positively related to the rate of adoption of innovations.	8	0	100

as perceived by members of a social system, is positively related to its rate of adoption (Generalization 6-4).

Observability is the degree to which the results of an innovation are visible to others. The observability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption (Generalization 6-5).

Rate of adoption is the relative speed with which an innovation is adopted by members of a social system. In addition to the perceived attributes of an innovation, such other variables affect its rate of adoption as (1) the type of innovation decision, (2) the nature of communication channels diffusing the innovation at various stages in the innovation-decision process, (3) the nature of the social system, and (4) the extent of change agents' efforts in diffusing the innovation.

The *diffusion effect* is the cumulatively increasing degree of influence upon an individual to adopt or reject an innovation, resulting from the activation of peer networks about an innovation in a social system. As the rate of awareness knowledge in a social system increases up to about 20 or 30 percent, there is very little adoption, but once this threshold is passed, further increases in awareness knowledge lead to increases in adoption. The diffusion effect is greater in a social system with a higher degree of *interconnectedness* (the degree to which the units in a social system are linked by interpersonal networks). The degree of interconnectedness in a social system is positively related to the rate of adoption of innovations (Generalization 6-6).

Overadoption is the adoption of an innovation when experts feel that it should be rejected.

CHAPTER 7

Innovativeness and Adopter Categories

Be not the first by whom the new are tried,
Nor the last to lay the old aside.

Alexander Pope (1711),
An Essay of Criticism, Part II.

The innovator makes enemies of all those who prospered under the old order, and only luke-warm support is forthcoming from those who would prosper under the new.

Niccolo Machiavelli
(1513, p. 51), *The Prince.*

A slow advance in the beginning, followed by rapid and uniformly accelerated progress, followed again by progress that continues to slacken—until it finally stops: These are the three ages of . . . invention . . . . If taken as a guide by the statistician and by the sociologist, [they] would save many illusions.

Gabriel Tarde (1903, p. 127),
The Laws of Imitation.

NOT ALL INDIVIDUALS IN A SOCIAL SYSTEM adopt an innovation at the same time. Rather, they adopt in a time sequence, and they may be classified into adopter categories on the basis of when they first begin using a new idea. We could describe each individual adopter in a social system in terms of his or her time of adoption, but this would be tedious work. It is much easier and more meaningful to describe adopter categories (the classifications of members of a system on the basis of innovativeness), each of which contains individuals with a similar degree of innovativeness. There is much practical usefulness

for change agents if they can identify potential innovators and laggards in their client audience and use different strategies with each such subaudience.

We know more about *innovativeness,* the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system, than about any other concept in diffusion research (Chapter 2). The expressed short-term goal of most change agencies is to facilitate the adoption of innovations by their clients. Because increased innovativeness is the objective of change agencies, it became the main dependent variable in the diffusion research sponsored by these change agencies. A further reason for the prime focus on innovativeness in diffusion research, especially in developing countries, is that innovativeness is one of the best single indicators of the success of development programs. Innovativeness indicates behavioral change, the ultimate goal of most diffusion programs, rather than cognitive or attitudinal change.

This chapter suggests one method of categorizing adopters and demonstrates the usefulness of this technique with research findings about the characteristics of adopter categories. We shall discuss the normality of adopter distributions, the method of classifying adopters, characteristics of adopter categories, and predicting innovativeness.

Classifying Adopter Categories on the Basis of Innovativeness

Titles of adopter categories were once about as numerous as diffusion researchers themselves. The inability of diffusion researchers (in the early days of diffusion research) to agree on common semantic ground in assigning terminology led to a plethora of adopter descriptions. The most innovative individuals were termed "progressists," "high-triers," "experimentals," "lighthouses," "advance scouts," and "ultraadopters." Least innovative individuals were called "drones," "parochials," and "diehards." The fertile disarray of adopter categories and methods of categorization, illustrated by the adopter categories, emphasized the need for standardization. How could a reader compare research findings about adopter categories until there was standardization of both the nomenclature and the classification system? Fortunately, one method of adopter categorization proposed

by Rogers (1962) gained a dominant position. It is based upon the s-shaped curve of adoption.

The S-Curve of Adoption and Normality

The time variable allows researchers to classify adopter categories and to plot diffusion curves. Past research has generally shown that the adoption of an innovation follows a normal, bell-shaped curve when plotted over time on a frequency basis. If the cumulative number of adopters is plotted, the result is an s-shaped curve. Figure 7-1 shows that the same adoption data can be represented by either a bell-shaped (frequency) or an s-shaped (cumulative) curve.

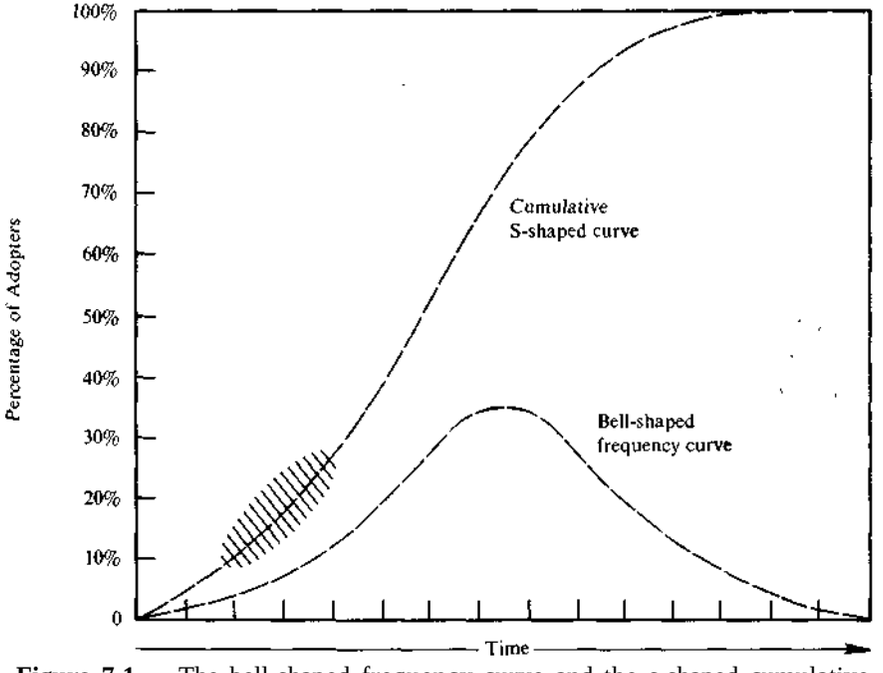

Figure 7-1. The bell-shaped frequency curve and the s-shaped cumulative curve for an adopter distribution.

Note that both of these curves are for the same data, the adoption of an innovation over time by the members of a social system. But the bell-shaped curve shows these data in terms of the number of individuals adopting each year, whereas the s-shaped curve shows these data on a cumulative basis. The shaded area marks the time period during which the s-curve of diffusion "takes off."

The s-shaped adopter distribution rises slowly at first when there are few adopters in each time period. It then accelerates to a maximum until half of the individuals in the system have adopted. It then increases at a gradually slower rate as the few remaining individuals finally adopt. This s-shaped curve is normal. Why? The reasoning rests on the role of information and uncertainty reduction in the diffusion of an innovation.

Psychological research indicates that individuals learn a new skill, or bit of knowledge, or set of facts, through a learning process that, when plotted over time, follows a normal curve. When an individual is confronted with a new situation in the psychologist's laboratory, the subject initially makes many errors. After a series of trials, the errors decrease until learning capacity has been reached. When plotted, these data yield a curve of increasing gains at first and later become a curve of decreasing gains. The gain in learning per trial is proportionate to (1) the product of the amount already learned, and (2) the amount remaining to be learned before the limit of learning is reached. The learning curve provides reason to expect adopter distributions to be normal. Many human traits are normally distributed, whether the trait is a physical characteristic, such as weight or height, or a behavioral trait, such as intelligence or the learning of information. Hence, a variable such as degree of innovativeness might be expected also to be normally distributed. If a social system is substituted for the individual in the learning curve, it seems reasonable to expect that experience with the innovation is gained as each successive member in the social system adopts it. Each adoption in the social system is in a sense equivalent to a learning trial by an individual.

In other words, we expect normal adopter distributions because of the *diffusion effect,* defined in Chapter 6 as the cumulatively increasing degree of influence upon an individual to adopt or reject an innovation, resulting from the activation of peer networks about the innovation in the social system. This influence results from the increasing rate of knowledge and adoption or rejection of the innovation in the system. Adoption of a new idea is the result of human interaction through interpersonal networks. If the first adopter of the « innovation discusses it with two other members of a social system, and each of these two adopters passes the new idea along to two peers, the resulting distribution follows a binomial expansion, a mathematical function that follows a normal shape when plotted over a series of successive generations. The process is similar to that of an unchecked infectious epidemic (Bailey, 1957, pp. 29-37, 155-159).

Of course, several of the assumptions underlying this hypothetical

example are seldom found in reality. For instance, members of a social system do not have completely free access to interact with one another. Status barriers, geographical location, and other variables affect diffusion patterns. The diffusion effect begins to level off after half of the individuals in a social system have adopted, because each new adopter finds it increasingly difficult to tell the new idea to a peer who has not yet adopted, for such nonknowers become increasingly scarce.

Previously (in Chapter 2) we argued that the S-shaped curve of diffusion "takes off" once interpersonal networks become activated in spreading subjective evaluations of an innovation from peer to peer in a social system (Figure 7-1). The area of the diffusion curve after about 10 percent adoption and up to 20 or 25 percent adoption is the heart of the diffusion process. After that point, it is probably impossible to stop the further diffusion of a new idea, even if one wishes to do so.

Generalization 7-1 states that: *Adopter distributions follow a bell-shaped curve over time and approach normality.* Evidence supporting this statement comes from investigations of agricultural, consumer, and other innovations in a variety of social systems, in the United States, India, and other nations (Rogers, 1958; Bose, 1964; Ryan, 1948; Beal and Rogers, 1960; Dimit, 1954; and Hamblin et al, 1973). A variety of different mathematical formulae have been proposed fit, and explain, the shape of adopter distributions. But all of this work is generally in agreement that the s-shaped curves are essentially normal. This point has useful implications for classifying adopter categories.

The Method of Adopter Categorization

A researcher seeking standardization of adopter categories faces three problems: (1) determining the number of adopter categories to conceptualize, (2) deciding on the portion of the members of a system to include in each category, and (3) determining the method, statistical or otherwise, of defining the adopter categories.

There is no question, however, about the criterion for adopter categorization. It is innovativeness, the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system. Innovativeness is a "relative" dimension, in that one has either more or less of it than others in a social system. Innovativeness is a continuous variable, and partition-Jug-it into discrete categories is only a conceptual device, much like

dividing the continuum of social status into upper, middle, and lower classes. Such classification is a simplification that aids understanding, although it loses data.

Before describing a proposed method of adopter categorization, it is important to specify the characteristics that a set of categories should possess. Ideally, categories should be: (1) *exhaustive,* or include all the units of study, (2) *mutually exclusive,* or exclude from any other category a unit of study that appears in one category, and (3) derived from *one classificatory principle.*

We have previously demonstrated that adopter distributions closely approach normality. This is important because the normal frequency distribution has several characteristics that may be used in clasifying adopters. One of these characteristics or parameters is the mean *(x),* or average, of the sample. Another parameter of a distribution is the standard deviation *(sd),* a measure of dispersion about the mean. The standard deviation explains the average amount of variance on either side of the mean for a sample.

These two statistics, the mean *(x)* and the standard deviation *(sd),* can be used to divide a normal adopter distribution into categories. If vertical lines are drawn to mark off the standard deviations on either side of the mean, the curve is divided into categories in a way that results in a standardized percentage of respondents in each category. Figure 7-2 shows the normal frequency distribution divided into five adopter categories: (1) innovators, (2) early adopters, (3) early majority, (4) later majority, and (5) laggards. These five adopter categories and the approximate percentage of individuals included in each are located on the adopter distribution in Figure 7-2.

The area lying to the left of the mean time of adoption minus two standard deviations includes the first 2.5 percent of the individuals to adopt an innovation—the *innovators.* The next 13.5 percent to adopt the new idea are included in the area between the mean minus one standard deviation and the mean minus two standard deviations; they are labeled *early adopters.* The next 34 percent of the adopters, called *early majority,* are included in the area between the mean date of adoption and minus one standard deviation. Between the mean and one standard deviation to the right of the mean are located the next 34 percent to adopt the new idea, the *late majority.* The last 16 percent are called *laggards.*

This method of adopter classification is not a symmetrical classification in that there are three adopter categories to the left of the mean and only two to the right. One solution would be to break laggards into two categories, such as early and late laggards, but laggards

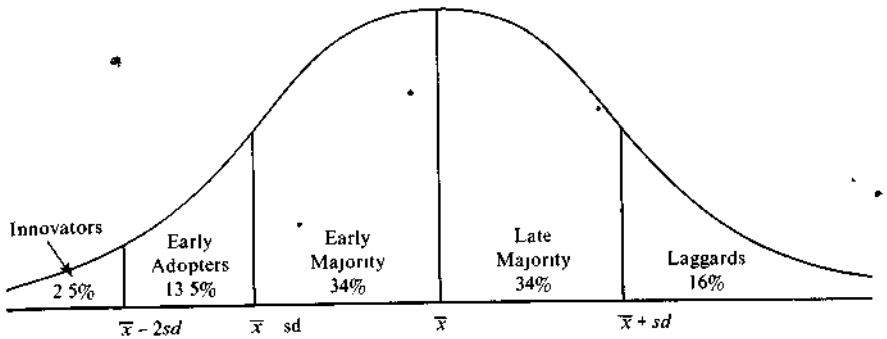

Figure 7–2. Adopter categorization on the basis of innovativeness.

The innovativeness dimension, as measured by the time at which an individual adopts an innovation or innovations, is continuous. This variable, however, may be partitioned into five adopter categories by laying off standard deviations from the average time of adoption.

seem to form a fairly homogeneous category. Similarly, innovators and early adopters could be combined into a single class to achieve symmetry, but their quite different characteristics mark them as two distinct categories.

Another difficulty in our method of adopter classification is incomplete adoption, which occurs for innovations that have not reached 100 percent use at the time of their study. This means that our fivefold classification scheme is not exhaustive. But the problem of incomplete adoption or nonadoption is eliminated when a series of innovations is combined into a composite innovativeness scale.

Three principles of categorization were suggested previously. Innovativeness as a criterion fulfills each of these requirements. The five adopter categories are exhaustive (except for nonadopters), mutually exclusive, and derived from one classification principle. The method of adopter categorization just described is the most widely used in diffusion research today.

Adopter Categories as **Ideal** Types

The five adopter categories set forth in this chapter are ideal types. *Ideal types* are conceptualizations based on observations of reality and designed to make comparisons possible. The function of ideal types is to guide research efforts and to serve as a framework for the synthesis of research findings.

Actually, there are no pronounced breaks in the innovativeness continuum between each of the five categories. Ideal types are not simply an average of all observations about an adopter category. Exceptions to the ideal types must be found. If no exceptions or deviations could be located, ideal types would not be necessary. Ideal types are based on abstractions from empirical cases and are intended as a guide for theoretical formulations and empirical investigations. They are not, however, a substitute for these investigations.

We now present a thumbnail sketch of the dominant characteristics and values of each adopter category, which will be followed by more detailed generalizations.

Innovators: Venturesome

Observers have noted that venturesomeness is almost an obsession with innovators. They are very eager to try new ideas. This interest leads them out of a local circle of peer networks and into more cosmopolite social relationships. Communication patterns and friendships among a clique of innovators are common, even though the geographical distance between the innovators may be considerable. Being an innovator has several prerequisites. These include control of substantial financial resources to absorb the possible loss owing to an unprofitable innovation and the ability to understand and apply complex technical knowledge. The innovator must be able to cope with the high degree of uncertainty about an innovation at the time that the innovator adopts.

The salient value of the innovator is venturesomeness. He or she desires the hazardous, the rash, the daring, and the risky. The innovator must also be willing to accept an occasional setback when one of the new ideas he or she adopts proves unsuccessful, as inevitably happens. While an innovator may not be respected by the other members of a social system, the innovator plays an important role in the diffusion process: that of launching the new idea in the social system by importing the innovation from outside of the system's boundaries. Thus, the innovator plays a gatekeeping role in the flow of new ideas into a social system.

Early Adopters: Respectable

Early adopters are a more integrated part of the local social system than are innovators. Whereas innovators are cosmopolites, early

adopters are localites. This adopter category, more than any other, has the greatest degree of opinion leadership in most social systems. Potential adopters look to early adopters for advice and information about the innovation. The early adopter is considered by many as "the individual to check with" before using a new idea. This adopter category is generally sought by change agents to be a local missionary for speeding the diffusion process. Because early adopters are not too far ahead of the average individual in innovativeness, they serve as a role model for many other members of a social system. The early adopter is respected by his or her peers, and is the embodiment of successful and discrete use of new ideas. And the early adopter knows that to continue to earn this esteem of colleagues and to maintain a central position in the communication structure of the system, he or she must make judicious innovation decisions. So the role of the early adopter is to decrease uncertainty about a new idea by adopting it, and then conveying a subjective evaluation of the innovation to near-peers by means of interpersonal networks.

Early Majority: Deliberate

The early majority adopt new ideas just before the average member of a social system. The early majority interact frequently with their peers, but seldom hold leadership positions. The early majority's unique position between the very early and the relatively late to adopt makes them an important link in the diffusion process. They provide interconnectedness in the system's networks.

The early majority may deliberate for some time before completely adopting a new idea. Their innovation-decision period is relatively longer than that of the innovator and the early adopter. "Be not the first by which the new is tried,/Nor the last to lay the old aside" (quoted from Alexander Pope at the beginning of this chapter), might be the early majority's motto. They follow with deliberate willingness in adopting innovations, but seldom lead.

Late Majority: Skeptical

The late majority adopt new ideas just after the average member of a social system. Adoption may be both an economic necessity and the answer to increasing network pressures. Innovations are approached with a skeptical and cautious air, and the late majority do not adopt

until most others in their social system have done so. The weight of system norms must definitely favor the innovation before the late majority are convinced. They can be persuaded of the utility of new ideas, but the pressure of peers is necessary to motivate adoption. Their relatively scarce resources mean that almost all of the uncertainty about a new idea must be removed before the late majority feel that it is safe to adopt.

Laggards: Traditional

Laggards are the last in a social system to adopt an innovation. They possess almost no opinion leadership. They are the most localite in their outlook of all adopter categories; many are near isolates in social networks. The point of reference for the laggard is the past. Decisions are often made in terms of what has been done in previous generations and these individuals interact primarily with others who also have relatively traditional values. When laggards finally adopt an innovation, it may already have been superseded by another more recent idea that is already being used by the innovators. Laggards tend to be frankly suspicious of innovations and change agents. Their traditional orientation slows the innovation-decision process to a crawl, with adoption lagging far behind awareness-knowledge of a new idea. While most individuals in a social system are looking to the road of change ahead, the laggard's attention is fixed on the rear-view mirror. This resistance to innovations on the part of laggards may be entirely rational from the laggards' viewpoint, as their resources are limited and so they must be relatively certain that a new idea will not fail before they can afford to adopt. The laggard's precarious economic position forces these individuals to be extremely cautious in adopting innovations.

Many observers have noted that "laggard" is a bad name, and it is undoubtedly true that this title of the adopter category carries an invidious distinction (in much the same way that "lower class" is a negative nomenclature). Laggard is a bad name because most nonlaggards have a strong pro-innovation bias. Diffusion scholars who use adopter categories in their research do not mean any particular disrespect by the term "laggard." Indeed if they used any other term instead of laggards, it would soon have a similar negative connotation. But it is a mistake to imply that laggards are somehow at fault for being relatively late to adopt; this is an illustration of individual-blame

where system-blame may more accurately describe much of the reality of the laggards' situation.

Characteristics of Adopter Categories

A tremendous research literature has accumulated about variables related to innovativeness, and here we summarize this diffusion research in a series of generalizations under the following headings: (1) socioeconomic status, (2) personality variables, and (3) communication behavior.

Socioeconomic Characteristics

Generalization 7-2: *Earlier adopters are not different from later adopters in age.* There is inconsistent evidence about the relationship of age and innovativeness; about half of the 228 studies on this subject show no relationship, 19 percent show that earlier adopters are younger, and 33 percent indicate they are older.*

Generalization 7-3: *Earlier adopters have more years of education than later adopters have.*

Generalization 7-4: *Earlier adopters are more likely to be literate than are later adopters.*

Generalization 7-5: *Earlier adopters have higher social status than later adopters.* Status is indicated by such variables as income, level of living, possession of wealth, occupational prestige, self-perceived identification with a social class, and the like. But however measured, about two-thirds of such inquiries find a positive relationship of social status with innovativeness.

Generalization 7-6: *Earlier adopters have a greater degree of upward social mobility than later adopters.* Although definitive empirical support is lacking, our evidence suggests that earlier adopters are not only of higher status but are on the move in the direction of still higher levels of social status. In fact, they may be using the adoption of innovations as one means of getting there.

*Rogers (1962, pp. 173-174) reanalyzed Gross' (1942) original data to demonstrate that there are wider differences in age between adopter categories when age at the time of *adoption* of hybrid seed was used, rather than age at the time of *interview.*

Generalization 7-7: *Earlier adopters have larger-sized units (farms, companies, and so on) than later adopters* (Figure 7-3).

Generalization 7-8: *Earlier adopters are more likely to have a commercial (rather than a subsistence) economic orientation than are later adopters.* A subsistence orientation is typified by a village farmer who produces only for his own consumption and not for sale Innovativeness is higher with the advent of a commercial orientation in which farm products are raised for market.

Generalization 7-9: *Earlier adopters have a more favorable attitude toward credit (borrowing money) than later adopters.*

Generalization 7-10: *Earlier adopters have more specialized operations than later adopters.*

WHY SOCIOECONOMIC STATUS Is RELATED WITH INNOVATIVENESS

The social characteristics of earlier adopters generally mark them as more educated, of higher social status, and the like. They are wealthier, more specialized, and have larger-sized units. Socioeconomic status and innovativeness appear to go hand in hand. Do innovators innovate because they are rich, or are they rich because they innovate? The answer to this cause-and-effect question cannot be answered solely on the basis of available correlational data. There are, however, adequate reasons why social status and innovativeness vary together. Greatest profits go to the first to adopt; therefore, the innovator gams a financial advantage through his or her innovation Some new ideas are costly to adopt and require large initial outlays of capital. Only the wealthy units in a social system may be able to adopt these innovations. The innovators become richer and the laggards become relatively poorer through this process. Because the innovator is the first to adopt, he or she must take risks that can be avoided by later adopters, who do not wish to cope with the high degree of uncertainty concerning the innovation when it is first introduced into the system. Certain of the innovator's new ideas are likely to fail. He or she must be wealthy enough to absorb the loss from these occasional failures. Although wealth and innovativeness are highly related economic factors do not offer a complete explanation of innovative behavior (or even approach doing so). For example, although agricultural innovators tend to be wealthy, there are many rich farmers who are not innovators.

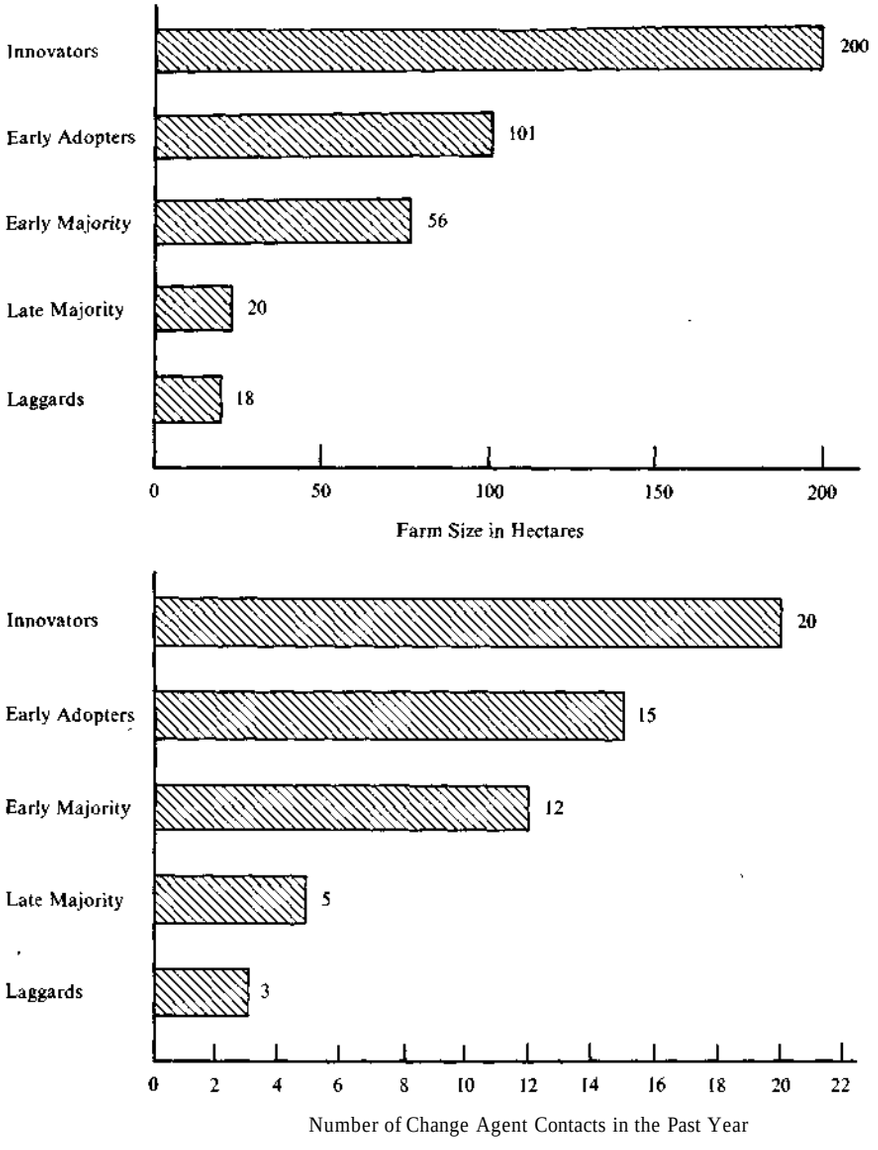

Figure 7-3. Innovators have large farms and more change agent contact than any other adopter category.

These data were obtained from personal interviews with 1,207 Brazilian farmers in 1966. The five adopter categories were classified on the basis of the farmers' agricultural innovativeness scores, composed of a number of new farming ideas. The generally linear trend across the five adopter categories, from innovators to laggards, in average farm size and change agent contact depicted here, also exists for many other characteristics of adopter categories (both in this Brazilian project and most other research studies).

Source: Rogers et al (1970).

THE "CANCIAN DIP": UNCERTAINTY, INNOVATIVENESS, AND SOCIOECONOMIC STATUS

All of the generalizations just presented concerning socioeconomic status and innovativeness assume a positive *and linear* relationship between these pairs of variables. That is, it is assumed that individuals adopt innovations in direct proportion to their socioeconomic status; with each added unit of income, size, and other socioeconomic status variables, an individual is expected to become more innovative.

The linearity of the socioeconomic-innovativeness relationship, however, began to be questioned by Professor Frank Cancian, an anthropologist at the University of California at Irvine, in 1967. The Cancian theory does not dispute that innovativeness and socioeconomic status go together at the extremes; that is, individuals of highest socioeconomic status are highly innovative, and those of lowest socioeconomic status are least innovative. But between these two extremes, Cancian argues that individuals of low-middle socioeconomic status are more innovative than individuals of high-middle status, especially in the early stages of the diffusion of an innovation (say, until about *25* percent adoption has occurred in the social system) when the degree of uncertainty concerning the innovation is highest. Later, when, say, 50 percent adoption has been reached, Cancian proposes that the high-middle individuals catch up and pass the low-middle individuals, thus resulting in a more linear relationship between socioeconomic variables and innovativeness.

This "Cancian Dip," as it has come to be called by diffusion researchers, is depicted in Figure 7-4. Cancian's theory is based upon the degree of uncertainty regarding an innovation's performance, and how such uncertainty gradually decreases as the rate of adoption of an innovation increases in a social system. Such thinking is certainly consistent with the main theme of the present book. Basically, Cancian proposes that when uncertainty is high (early in an innovation's diffusion), low-middle individuals will be more innovative than the high-middle individuals in a social system because they have less to lose. Later, when the innovation has diffused more widely and is perceived as less uncertain, the greater socioeconomic resources of the high-middle individuals enable them to adopt at a faster rate than the low-middle individuals, and to catch up and surpass them in innovativeness. So the curvilinear relationship of socioeconomic status and innovativeness owing to the "Cancian dip" is a temporary condition, replaced by a linear relationship later in the diffusion process.

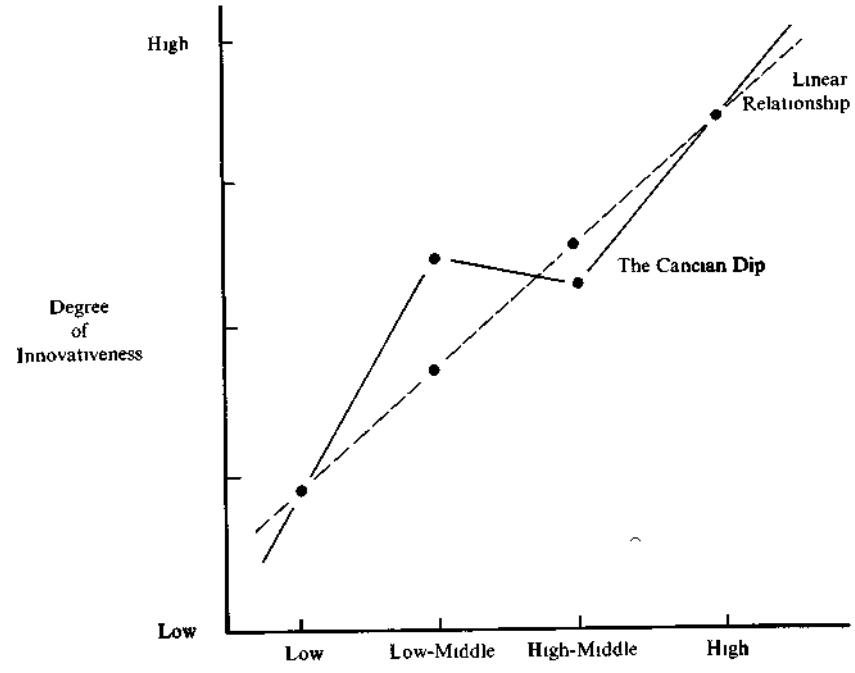

Figure 7-4. A linear relationship between innovativeness and various measures of socioeconomic status has generally been assumed in past research but reanalyses of these data suggest that the "Cancian Dip" may sometimes be present, in which low-middle individuals are more innovative than high-middle individuals, at least in the early phase of the diffusion process.

Professor Frank Cancian proposed a nonlinear theory of innovativeness and socioeconomic status, in which low-middle individuals are more innovative than high-middle individuals because they stand to gain more and to lose less by such innovativeness. There is some support for the "Cancian dip" hypothesis although there is also a good deal of contradictory evidence.

Dr. Cancian also makes quite a point of the necessity to measure *local* socioeconomic status rather than societal stratification; that is, socioeconomic status is measured as an individual's status relative to other members of his or her social system, not in comparison to everyone else in the nation. For example, if Cancian is analyzing data from a sample of Mexican farmers, he would prefer to express each farmer's income in rank order to all other farmer's incomes in the same village, rather than using absolute income figures; so an in-

dividual with an annual income of $ 1,000 might be in the top 5 percent of his village, but only in the 60 percentile rank of all Mexicans in a national sample. In other words, Cancian feels that relative social position in one's local system is a better predictor of innovative behavior than is absolute position in a larger system (in which the individual presumably does not compare him or herself): "Behavior is better understood when people are seen as occupants of social positions defined relative to a social system" (Cancian, 1981). Professor Cancian notes, however, that the measurement of relative socioeconomic status is often very difficult for diffusion researchers.

Needless to say, the "Cancian dip" hypothesis is a complicated and difficult thesis to test with empirical data. Cancian himself has pioneered in such research, proposing the main measures and methodologies to be used (Cancian, 1967, 1976, 1977, 1979a, 1979b, 1980). His work has set off a wide variety of retests, refutations, and discussions of this theory.* Much of the research, Both by Cancian and by other diffusion scholars, consists of reanalysis of existing data sets that were originally collected without the intention of testing the "Cancian dip" hypothesis.* By far the most enthusiastic of these reanalyses consists of data from over 6,000 farmers who were interviewed in twenty-three different research studies; each of these original investigators provided their data to Cancian (1976). What conclusions can be reached from this analysis? In twenty-three of the forty-nine data sets (each representing a farming system in which an agricultural innovation was at approximately 25 percent adoption), the "Cancian dip" was supported in that the low-middle individuals were more innovative than the upper-middle. In twenty-six of the forty-nine situations, the "Cancian dip" was not found (Cancian, 1979a, p. 73).

So overwhelming evidence in support of the "Cancian dip" hypothesis was not found, although it seems that it is no longer safe to assume that socioeconomic status and innovativeness are related in a linear fashion, especially at an early stage in the diffusion process. If only the data sets from developing nations were considered, the ‘‘Cancian dip" hypothesis is supported seventeen to nine. The second part

*These publications include Boyd (1980), Gartrell (1977), Gartrell et al (1973), Frey and Freeman (1981), Frey et al (1979), Morrison et al (1976), Rogers et al (1970), Wagener et al (1981), and Wilkening et al (1969).

* Thus these researches represent a special type of *meta-research,* defined as the synthesis of empirical research results into more general conclusions at a theoretical level (Rogers, 1981b).

of the Cancian thesis, that the high-middle individuals catch up with the low-middle later in the diffusion process (at about a 50 percent rate of adoption) was supported twenty-five to twenty-four (Cancian, 1979b, p. 73).

Certainly, further research is needed before the Cancian notion of high-middle conservatism in facing innovation uncertainty can be accepted or rejected. To date, Professor Cancian has made an important contribution in alerting diffusion scholars and change agents that the relationships of socioeconomic status (and perhaps other independent variables) with innovativeness should not be assumed to be linear.

Personality Variables

Personality variables associated with innovativeness have not yet received much research attention, in part because of difficulties of measuring personality dimensions in field interviews.

Generalization 7-11: *Earlier adopters have greater empathy than later adopters.* Empathy is the ability of an individual to project him or herself into the role of another person. This ability is an important quality for the innovator, who must be able to think counterfactually, to be imaginative, and to take the roles of heterophilous others in order to communicate effectively with them. To a certain extent, the innovator must be able to project into the role of individuals outside of the local system (as the innovator is the first to adopt in the local social system): innovators in other systems, change agents, and even R&D workers.

Generalization 7-12: *Earlier adopters may be less dogmatic than later adopters.* Dogmatism is the degree to which an individual has a relatively closed belief system, that is, a set of beliefs that are strongly held. We would not expect a highly dogmatic person to welcome new ideas; such an individual would instead prefer to hew to the past in a closed manner. Evidence in support of this generalization is not very strong.

Generalization 7-13: *Earlier adopters have a greater ability to deal with abstractions than later adopters.* Innovators must be able to adopt a new idea largely on the basis of abstract stimuli, such as are received from the mass media. But later adopters can observe the innovation in the here and now of a peer's operation. They may, therefore, need less ability to deal with abstractions.

Generalization 7-14: *Earlier adopters have greater rationality than*

later adopters. Rationality is use of the most effective means to reach a given end.

Generalization 7-15: *Earlier adopters have greater intelligence than later adopters.*

Generalization 7-16: *Earlier adopters have a more favorable attitude toward change than later adopters.*

Generalization 7-17: *Earlier adopters are more able to cope with uncertainty and risk than later adopters.*

Generalization 7-18: *Earlier adopters have a more favorable attitude toward education than later adopters.*

Generalization 7-19: *Earlier adopters have a more favorable attitude toward science than later adopters.* Because most innovations are the products of scientific research, it is logical that innovators should be more favorably inclined toward science.

Generalization 7-20: *Earlier adopters are less fatalistic than later adopters.* Fatalism is the degree to which an individual perceives a lack of ability to control his or her future. An individual is more likely to adopt an innovation if he or she believes that he or she is in control, rather than thinking that the future is determined by fate.

Generalization 7-21: *Earlier adopters have higher levels of achievement motivation than later adopters.* Achievement motivation is a social value that emphasizes a desire for excellence in order for an individual to attain a sense of personal accomplishment.

Generalization 7-22: *Earlier adopters have higher aspirations (for education, occupations, and so on) than later adopters.*

Communication Behavior

Generalization 7-23: *Earlier adopters have more social participation than later adopters.*

Generalization 7-24: *Earlier adopters are more highly interconnected in the social system than later adopters.* Connectedness is the degree to which a unit is linked to other units.

Generalization 7-25: *Earlier adopters are more cosmopolite than later adopters.* The innovators' networks are more likely to be outside, rather than within, their social system. They travel widely and are involved in matters beyond the boundaries of their local system. For instance, as shown in Chapter 2, Iowa hybrid corn innovators traveled to urban centers like Des Moines more often than the average farmer (Ryan and Gross, 1943). Medical doctors who innovated a new drug

attended more out-of-town professional meetings than noninnovators (Coleman et al, 1966). Cosmopoliteness is the degree to which an individual is oriented outside the social system.

Generalization 7-26: *Earlier adopters have more change agent contact than later adopters* (Figure 7-3).

Generalization 7-27: *Earlier adopters have greater exposure to mass media communication channels than later adopters.*

Generalization 7-28: *Earlier adopters have greater exposure to interpersonal communication channels than later adopters.*

Generalization 7-29: *Earlier adopters seek information about innovations more actively than later adopters.*

Generalization 7-30: *Earlier adopters have greater knowledge of innovations than later adopters.*

Generalization 7-31: *Earlier adopters have a higher degree of opinion leadership than later adopters.* Although innovativeness and opinion leadership are positively related, the exact degree to which these two variables are related depends in part on the norms of the social system. In a system with norms favorable to change, opinion leaders are more likely to be innovators (Chapter 8).

Generalization 7-32: *Earlier adopters are more likely to belong to highly interconnected systems than are later adopters.* The internal "trickle-down" of new ideas in a well-integrated system is faster, enabling the members of such systems to learn about new ideas more rapidly.

A Summary of the Characteristics of Adopter Categories

In summary, we see that in most of the previous generalizations, an independent variable is positively related to innovativeness (Figure 7-5 and Table 7-1). This means that innovators will score higher on these variables than laggards. For instance, Rogers with Svenning (1969, p. 300) found that in traditional Colombian villages the innovators averaged 30 trips a year to cities whereas the laggards averaged only 0.3 trips. Figure 7-4 provided two other examples of the positive relationships between innovativeness and the characteristics of adopter categories: Brazilian innovators were shown to have much larger-sized farms and more change agent contact than other adopter categories.

A few variables, such as dogmatism and fatalism, are negatively related to innovativeness (Figure 7-5), and opinion leadership is greatest for early adopters, at least in most systems.

Table 7-1. A Summary of the Research Evidence Supporting and Not Supporting Generalizations about the Characteristics of Adopter Categories.

Generalization	Direction in which the Independent Variable Is Related to Innovativeness	Support for the Generalization (Number of Research Studies)		Percentage of Research Studies Supporting the Generalization
		Supporting	*Not Supporting*	
I. *Socioeconomic Characteristics*				
7-2	Age (not related)	108	120*	48
7-3	Education (positive)	203	72	74
7-4	Literacy (positive)	24	14	63
7-5	Higher social status (positive)	275	127	68
7-6	Upward social mobility (positive)	5	0	100
7-7	Larger-sized units (positive)	152	75	67
7-8	A commercial, rather than a subsistence, economic orientation (positive)	20	8	71
7-9	A more favorable attitude toward credit (positive)	19	6	76
7-10	More specialized operations (positive)	9	6	60
II. *Personality Variables*				
7-11	Empathy (positive)	9	5	64
7-12	Dogmatism (negative)	17	19	47
7-13	Ability to deal with abstractions (positive)	5	3	63
7-14	Rationality (positive)	11	3	79
7-15	Intelligence (positive)	5	0	100
7-16	A more favorable attitude toward change (positive)	43	14	75
7-17	Ability to cope with uncertainty (positive)	27	10	73
7-18	A more favorable attitude toward education (positive)	25	6	81
7-19	A more favorable attitude toward science (positive)	20	7	74
7-20	Fatalism (negative)	14	3	82
7-21	Achievement motivation (positive)	14	9	61
7-22	Higher aspirations for education, occupations, etc. (positive)	29	10	74
III. *Communication Behavior*				
7-23	Social participation (positive)	109	40	73
7-24	Interconnectedness with the social system (positive)	6	0	100
7-25	Cosmopoliteness (positive)	132	42	76
7-26	Change agent contact (positive)	135	21	87
7-27	Mass media exposure (positive)	80	36	69
7-28	Exposure to interpersonal communication channels (positive)	46	14	77
7-29	More active information seeking (positive)	12	2	86
7-30	Knowledge of innovations (positive)	61	19	76
7-31	Opinion Leadership (positive)	42	13	76
7-32	Belonging to highly interconnected systems (positive)	8	7	53

*Of these 120 studies, 44 show that earlier adopters are younger, and 76 show that earlier adopters are older.

Source: A content analysis of the approximately 900 empirical publications dealing with the diffusion of innovations available in July 1968 (Rogers with Shoemaker, 1971, pp. 352-376). While considerable further research has been conducted on the characteristics of adopter categories since 1968 (the total number of diffusion publications has approximately doubled), most of this investigation has followed the same directions as previously and my reading of all these studies suggests that the present conclusions would not be changed much if they were more up to date.

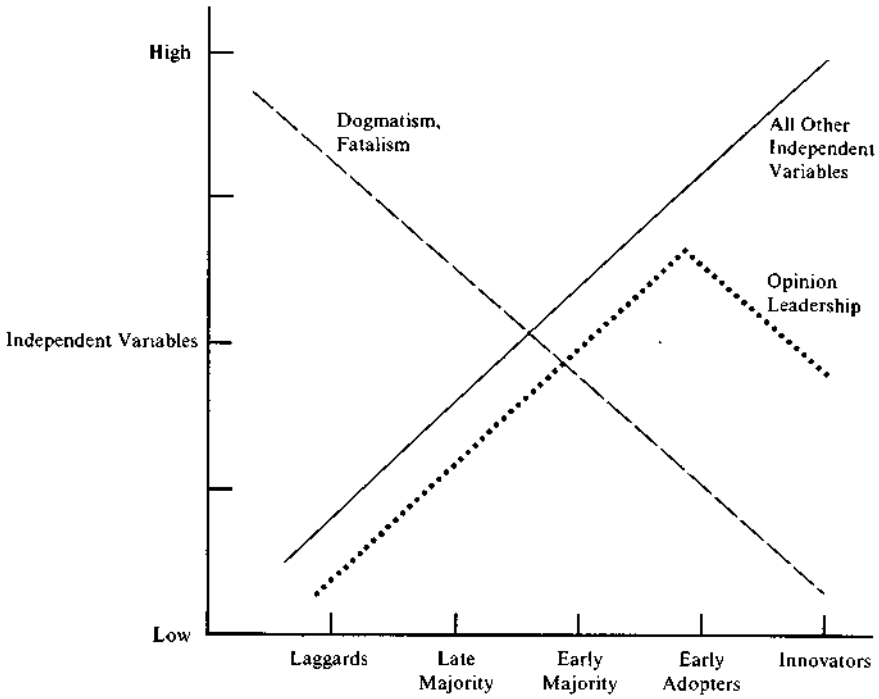

Figure 7-5. Most of the independent variables are positively related to the dependent variable of innovativeness in the thirty-one generalizations about characteristics of adopter categories.

Twenty-seven of the independent variables, such as social status, cosmopoliteness, and the like, are positively related with innovativeness. Two variables, however, dogmatism and fatalism, are negatively related, and opinion leadership seems greatest for early adopters, at least in most systems. We have not shown the ''Cancian Dip" here, which may occur for certain socioeconomic variables related to innovativeness.

Thus, a set of general characteristics of each adopter category has emerged from diffusion research. The important differences among these categories suggest that change agents should use somewhat different approaches with each adopter category, thus following a strategy of audience segmentation.* Thus, one might appeal to innovators who adopted an innovation because it was soundly tested and developed by credible scientists, but this approach would not be effective with the late majority and the laggards, who do not have such a favorable attitude toward science. They will not adopt a new idea until they feel that most uncertainty about the innovation's performance has been removed; these later adopters place greatest credibility in the subjective experiences of their peers with the innovation, conveyed to them through interpersonal networks.

** Audience segmentation* is a diffusion strategy in which different communication channels or messages are used with each audience segment. This strategy has the advantage of breaking down a heterophilous audience into a series of relatively more homophilous subaudiences.

An implication for change agents from research on the correlates of innovativeness is that if we could change the characteristics of individuals or organizations so that they more closely resembled the characteristics of the highly innovative, we would then make the individuals or organizations more innovative (Eveland, 1979). This veiwpoint rests on the assumption that the characteristics associated with innovativeness are flexible and dynamic, so as to be altered by change agents (on the contrary, several of the variables associated with innovativeness—for example, age and size of unit—are difficult or impossible to change). Further, the innovativeness-creation strategy assumes that the independent variables (such as socioeconomic status or cosmopoliteness) *cause* innovativeness; actually, we only know that these variables are *associated* with innovativeness. So even if we could change these characteristics variables, there is no reason to believe that greater innovativeness would result. Finally, one might question whether increased innovativeness for all the members of a social system would always be a desirable end (unless, of course, one had a strong pro-innovation bias).

We conclude that one of the main uses of research on the characteristics of adopter categories is to provide a basis for audience segmentation strategies by diffusion agencies. Further, our understanding of the variables associated with innovativeness helps provide insight into the socioeconomic consequences of diffusion, a topic discussed in the following section and in Chapter 11.

The Innovativeness-Needs Paradox

Those individuals or other units in a social system who most need the benefits of a new technological idea (the less educated, less wealthy, and the like) are generally the last to adopt that innovation. The units in a system who adopt first generally least need the benefits of the innovation. This paradoxical relationship between innovativeness and

the need for benefits of an innovation tends to result in a wider socioeconomic gap between the higher and lower socioeconomic individuals in a social system. Thus, one consequence of many technological innovations is to widen socioeconomic gaps in a social system (as is detailed in Chapter 11).

One illustration of this paradox is the adoption of contraceptive innovations in developing nations. Elite families in these societies are already relatively small in size, even though these families could well afford to raise many children properly. When a national family planning program was launched by the government, these elite families were the first to adopt contraceptives (Rogers, 1973, p. 408). While elite families average two or three children, lower-status families average five or six children (that they often cannot afford to feed, clothe, or educate). The poorer families generally do not adopt contraceptive innovations, even though one might think those families would feel a stronger need for family planning. Thus, the paradox occurs in which those who might seem to need an innovation most are the last to adopt it.

What creates this paradox? In the case of family planning, poor families believe that having many children (especially sons) is an economic asset, in that the sons can assist with farm work, as well as providing a source of admiration from peers. Thus poor parents do not believe the officials who tell them that the small family is a happy family. A second reason for the paradoxical tendency of those who most need an innovation to adopt it last, is that change agents often follow a segmentation strategy of *least resistance,* in that they especially contact the socioeconomic elites, who are often most receptive to innovations (as we showed previously in Generalizations 7-3, 7-5, 7-7, and 7-26). Most contraceptive innovations require at least some degree of resources, skills, and/or training to adopt, which the nonelite members of a system are unlikely to possess. For example, most family-planning innovations are used more easily and more correctly by elite parents, as these technologies require the planning of time, and understanding of the human reproduction function, and other skills. So even when family-planning methods are provided at no cost by a government program, the socioeconomic elites tend to be more innovative, and adopt first.

The innovativeness-needs paradox need not occur, of course. Change agents could pursue a segmentation strategy of *greatest resistance,* in which communication efforts are concentrated on the subaudiences who are lowest in socioeconomic status, who feel the least need for the innovation, and who would otherwise be the last to adopt (Rogers, 1973, p. 408). An unfortunate consequence of the tendency of change agents to concentrate their efforts on their elite clients, while largely ignoring the hard-to-get subaudience of late majority and laggards, is widening gaps between the information-rich and the information-poor in a social system (Chapter 11).

Predicting Innovativeness with Multiple Correlation Techniques

So far in this chapter, we have looked only at two-variable generalizations, each consisting of an independent variable (a characteristic of adopter categories) that is related to the dependent variable of innovativeness. The resulting generalizations somewhat oversimplify reality, of course, by treating each independent variable separately in its relationship to innovativeness. Many of the independent variables are interrelated with each other, as well as with innovativeness. For instance, education and social status are both positively related to innovativeness (Generalizations 7-3 and 7-5), but education and social status are also positively related with each other. Statistical techniques like multiple correlation allow us to determine how much of the variance in innovativeness is uniquely explained by its co-variance with education, while removing the co-variance of both innovativeness and education with social status (and other independent variables).

Multiple correlation is a statistical procedure designed to analyze and explain the variance in a dependent variable in components that are due to the effects of various independent variables. The goal of the multiple correlation approach is to predict a maximum of the variance in the dependent variable, which in the present case is innovativeness. Multiple correlation analyses of innovativeness began in the mid-1950s, and over sixty such studies have been completed with a trend toward explaining more and more of the variance in innovativeness, until by the late 1960s up to about 80 percent of the variance in innovativeness was explained (Rogers with Shoemaker, 1971, p. 193). This may be partly attributable to the advent of computer data analysis, which allows the inclusion of a greater number of independent variables in these analyses. Further, a greater variety of independent variables were included in these studies: economic and social-psychological dimensions, along with variables indicating social-structural aspects.

In the late 1960s, a number of multiple correlation analyses were made of *organizational* innovativeness, in which the dependent variable is the degree to which an organization (rather than an individual) is innovative; here the unit of analysis is an organization. An illustration is Mohr's (1969) study of the innovativeness of county health departments, in which each such organization is credited with a higher innovativeness score for adopting new public health ideas. About 63 percent of the variance in organizational innovativeness was explained by such independent variables as the resources available to the organization, the attitudes of the director of the health department, and various organizational characteristics (Chapter 10).

Another recent trend in innovativeness-prediction research is to include independent variables that use (1) system-level variables, and (2) communication network variables, along with (3) individual-level variables, to predict individual innovativeness (Rogers and Kincaid, 1981, pp. 239-243). For example, system-level independent variables used by Lee (1977) included the average level of education in Korean villages and the average number of change agent contacts with the villagers. Network variables were also measured, such as the degree to which the individual is interconnected by network links with the rest of the village. Lee (1977) found that the individual-level and network variables were more important in explaining individual innovativeness in adopting family planning, than were the system-level variables. These results suggest that communication network variables should be considered for inclusion in future innovativeness-prediction studies (Rogers and Kincaid, 1981, p. 242). System-level variables (like a system's norms) may influence individual behavior (like innovativeness) through the individual's network links.

Future prediction studies of innovativeness need to continue these recent trends of including a wider diversity of types of independent variables, of levels of the units of analysis, and to consider other methods of prediction to supplement the technique of multiple correlation (such as clinical prediction and the configurational method of prediction*). The eventual *goal* of research to predict innovativeness is an improved understanding of the complex interrelationships

*The configurational method of prediction consists of dividing a sample of respondents into relatively homogeneous subsamples on the basis of the independent variables. Each subsample is regarded as a separate unit for analysis, since it has a unique configuration of independent variables. After these successive breakdowns on the basis of the independent variables, the probability of a certain outcome (such as adoption) is calculated. For illustrations of the configurational approach to predicting innovativeness, see Finley (1968), Rogers and Havens (1962a), Keith (1968), and Herzog et al (1968).

among each of the independent variables, acting together, in their association with innovativeness.

To date, diffusion research has concentrated too much (1) on investigating the characteristics of adopter categories, and (2) in studying a rather limited range of such characteristics variables. Do we really need a 276th study of the relationship of education to innovativeness (Table 7-1)? I think not. A much wiser use of research resources would be to explore other independent variables in their relationship with innovativeness, especially network variables and system-level variables that could help us escape the overwhelming "individualism" of past research on innovativeness, in which most of the independent variables of study were individual characteristics that did not encompass the interpersonal relationships that are also an important part of diffusion.

Perhaps instead of further research on innovativeness, future scholars should direct their investigations to other important aspects of the diffusion process.

Computer Simulation of Innovation Diffusion

Diffusion researchers have traditionally been bound by their research tools to examinations of slices or cross-sections of the process at one point in time. Methodological limits have necessitated slow-motion analyses that hold a slice of the process stationary while the dynamics of diffusion may be observed. Now, with the flexible time considerations provided by the computer, it is possible to fuse the stationary analysis with the continuing process and capture the important variables in action. This can be achieved with the technique of computer simulation.

The result of computer simulation is the reproduction of the social process that one seeks to mimic. If the simulated process does not correspond to reality data, one knows that adjustments are needed in the model (or set of rules) governing the simulated process.

Torsten Hagerstrand, a quantitative geographer at the University of Lund, Sweden, is the father of diffusion simulation research. His work on computer simulation began in the early 1950s, but was published only in Swedish so that for many years the language barrier prevented the diffusion of his important work to U.S. researchers. From the mid-1960s, however, Hagarstrand's work has been carried forward in a series of interesting investigations by quantitative

geographers and others. Examples of such simulations are the diffusion of deep well drilling in Colorado (Bowden, 1965a, 1965b) and of agricultural innovations in Colombia (Hanneman, 1969, 1971) and Brazil (Carroll, 1969). These studies and others like them suggest that computer simulation of diffusion holds promise as a means to explore the complexities of the diffusion process as it unfolds over time. This potential, however, has not yet been fully realized.

In the typical example of the Hagerstrand approach to diffusion simulation, the process begins with the first adopter of an innovation. The simulation's rules predict that the next adopter (1) will be relatively homophilous with the previous adopter in personal-socioeconomic characteristics (Hagerstrand, 1952, 1953, 1965, and 1969). These rules of simulated diffusion are carried out by a computer program that repeats them in a sequence of "generations," each of which is a period of time such as a month or a year (Pitts, 1967). Then, the simulated diffusion process is compared with data about the actual rate of adoption in order to determine the effectiveness of the simulation model.*

One of the contemporary intellectual leaders in diffusion simulation research is Professor Lawrence A. Brown of Ohio State University; his results and those of his colleagues (Brown, 1966; Brown and Moore, 1969; Brown et al, 1976; Garst, 1973, 1974, and 1975) demonstrate the important role of spatial distance in the person-to-person diffusion of an innovation. Unfortunately, nongeographical diffusion scholars have not paid sufficient attention to space as an important variable affecting the diffusion of innovations. In fact, space is probably one of the least-studied variables in the diffusion process (Brown, 1981).

Summary

Adopter categories are the classifications of members of a social system on the basis of *innovativeness,* the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system. A variety of categorization systems and titles for adopters have been used in past research studies. This chapter suggests the standard set of adopter categories that is widely followed today.

*In addition to its potential for diffusion research, computer simulation techniques can be used for training purposes. For instance, I designed a change agent training simulation game in the mid-1960s in which the trainee must choose among various diffusion strategies in order to maximize the rate of adoption of an innovation in a social system. This diffusion game was converted to a computer simulation training device by Professor Charles Weinberg when he was at the Stanford Business School. It is presently distributed at cost by the CONDUIT system, and may be obtained from James Johnson of the Computer Center at the University of Iowa, Iowa City.

Adopter distributions tend to follow an s-shaped curve over time and to approach normality (Generalization 7-1). One reason is because of the *diffusion effect,* defined as the cumulatively increasing degree of influence upon an individual to adopt or reject an innovation, resulting from the activation of peer networks about the innovation in the social system. This influence results from the increasing rate of knowledge and adoption or rejection of the innovation in the system.

The continuum of innovativeness can be partitioned into five adopter categories (innovators, early adopters, early majority, late majority, and laggards) on the basis of two characteristics of a normal distribution, the mean and the standard deviation. These five categories are *ideal types,* conceptualizations based on observations of reality and designed to make comparisons possible. Dominant attributes of each category are: innovators—venturesome; early adopters—respectable; early majority—deliberate; late majority-skeptical; and laggards—traditional. A series of generalizations summarize research findings about the socioeconomic characteristics of adopter categories. The relatively earlier adopters in a social system are no different from later adopters in age (Generalization 7-2), but they have more years of education (Generalization 7-3), are more likely to be literate (Generalization 7-4), have higher social status (Generalization 7-5), a greater degree of upward social mobility (Generalization 7-6), larger-sized units, like farms, companies, and so on (Generalization 7-7), a commercial rather than a subsistence economic orientation (Generalization 7-8), a more favorable attitude toward credit (Generalization 7-9), and more specialized operations (Generalization 7-10). These characteristics of adopter categories indicate generally that earlier adopters have higher socioeconomic status than later adopters. The "Cancian dip" questions whether the relationship between innovativeness and socioeconomic status is linear; this theory proposes that individuals of low-middle socioeconomic status are more innovative than individuals of high-middle status, especially in the early stages of diffusion of an innovation when the degree of uncertainty about the innovation is greatest. Reanalysis of various data sets provides some support for the Cancian dip, but there is also a good deal of contradictory evidence.

Earlier adopters in a system also differ from later adopters in per-

sonality variables. Earlier adopters have greater empathy (Generalization 7-11), less dogmatism (Generalization 7-12), a greater ability to deal with abstractions (Generalization 7-13), greater rationality (Generalization 7-14), greater intelligence (Generalization 7-15), a more favorable attitude toward change (Generalization 7-16), a greater ability to cope with uncertainty and risk (Generalization 7-17), a more favorable attitude toward education (Generalization 7-18), a more favorable attitude toward science (Generalization 7-19), less fatalism (Generalization 7-20), higher achievement motivation (Generalization 7-21), and higher aspirations for education, occupations, and so on (Generalization 7-22).

Finally, the adopter categories have different communication behavior. Earlier adopters have more social participation (Generalization 7-23), are more highly interconnected in the social system (Generalization 7-24), are more cosmopolite (Generalization 7-25), have more change agent contact (Generalization 7-26), greater exposure to mass-media channels (Generalization 7-27), greater exposure to interpersonal communication channels (Generalization 7-28), engage in more active information seeking (Generalization 7-29), have greater knowledge of innovations (Generalization 7-30), a higher degree of opinion leadership (Generalization 7-31), and are more likely to belong to highly interconnected systems (Generalization 7-32).

Past research, thus, shows many important differences between earlier and later adopters of innovations in (1) socioeconomic status, (2) personality variables, and (3) communication behavior.

CHAPTER 8

Opinion Leadership and Diffusion Networks

Men are generally incredulous, never really trusting new things unless they have tested them by experience.

Niccolo Machiavelli (1513, p. 51), *The Prince.*

Every herd of wild cattle has its leaders, its influential heads.

Gabriel Tarde (1903, p. 4), *The Laws of Imitation.*

THROUGHOUT THE PREVIOUS CHAPTERS of this book we emphasized the central importance of interpersonal network influences on individuals in convincing them to adopt innovations. Here we explore what is known about such diffusion networks and how they function to convey innovation-evaluation information to decrease uncertainty about use of a new idea. We begin with a discussion of *opinion leadership*, the degree to which an individual is able informally to influence other individuals' attitudes or overt behavior in a desired way with relative frequency. Opinion leaders are individuals who lead in influencing others' opinions about innovations. The behavior of opinion leaders is important in determining the rate of adoption of an innovation in a social system; in fact, the diffusion curve has its usual s-shape because of the time at which the opinion leaders adopt and owing to their ability to activate diffusion networks in a social system. In order to understand the nature of opinion leadership, we shall discuss (1) the various models of mass communication flow, such as the two-step flow and its revisions, (2) how homophily-heterophily affects the flow of communication, (3) mea-

sures of opinion leadership, and (4) characteristics of opinion leaders. We shall then explore the role of social modeling in diffusion networks, and how such interpersonnal communication drives the diffusion process.

Models of Mass Communication Flows

In order to understand better the nature of opinion leadership in diffusion, we now examine several models of mass communication flows, roughly in the temporal sequence of their entrance on the communication research scene.

Hypodermic Needle Model

The *hypodermic needle model* postulated that the mass media had direct, immediate, and powerful effects on a mass audience. The mass media in the 1940s and 1950s were perceived as an all-powerful influence on human behavior. The omnipotent media were pictured as conveying messages to atomized masses waiting to receive them, with nothing intervening (Katz and Lazarfeld, 1955, p. 16). Evidence of the manipulative power of the mass media were drawn from such historical events as: (1) the role of the Hearst newspapers in arousing public support for the Spanish-American War, (2) the power of Goebbel's propaganda machine during World War II, and (3) the influence of Madison Avenue advertising on consumer and voting behavior.

Eventually, when more sophisticated research methods were used in communication research, considerable doubt was cast on the hypodermic needle model. It was based primarily on intuitive theorizing about historical events and was too simple, too mechanistic, and too gross to give an accurate account of mass media effects.

The Two-Step Flow Model

The decisive discarding of the hypodermic needle model resulted serendipitously from a classic study of the 1940 presidential election (Lazarsfeld et al, 1944). This inquiry was designed with the hypodermic needle model in mind and was aimed at analyzing the role of mass

media in clinching political decisions. To the researchers' surprise, the evidence indicated that almost no voting choices were directly influenced by the mass media. Lazarsfeld and Menzel (1963, p. 96) admitted that: "This study went to great lengths to determine how the mass media brought about such changes. To our surprise we found the effect to be rather small. . . . People appeared to be much more influenced in their political decisions by face-to-face contact with other people . . . than by the mass media directly." Instead the data seemed to indicate "that ideas often *flow* from radio and print *to* opinion leaders and *from* these to the less active sections of the population" (Lazarsfeld et al, 1944, p. 151). The first step, from sources to opinion leaders, is mainly a transfer of *information,* whereas the second step, from opinion leaders to their followers, also involves the spread of *influence.* This *two-step flow hypothesis* has since been tested in a variety of communication situations and found generally to provide a usable conceptual framework for examining the flow of mass communication.

The two-step flow model helped focus attention upon the interface between mass media and interpersonal influence. It implied that the mass media were not so powerful nor so direct as was once thought. One may be exposed to a new idea either through mass media or interpersonal channels, and then engage in communication exchanges about the message with one's peers. The view that the mass communication process consists essentially of two steps limits analysis of the process. The mass communication process may involve more or fewer than two steps. In some instances there may be only one step: the mass media may have direct impact on a receiver. In other instances the impetus of the mass media may lead to a multistage communication process.

Different communication sources/channels function at different stages in an individual's innovation-decision process. The original two-step flow model did not recognize the role of different sources/channels at the varying stages of innovation decision. We know from Chapter 5 that individuals pass from (1) *knowledge* of an innovation, to (2) *persuasion,* to (3) a *decision* to adopt or reject, to (4) *implementation,* and then to (5) *confirmation* of this decision. Mass-media channels are primarily knowledge creators, whereas interpersonal networks are more important at persuading individuals to adopt or reject. This notion was masked in the original statement of the two-step model because the time sequence involved in the decision-making process was ignored. Such source/channel differences at the

knowledge versus the persuasion stages exist for *both* opinion leaders and followers. Thus, the opinion leaders are not the only ones to use mass-media channels, as the original statement of the two-step flow model seemed to suggest.

An overall criticism of the two-step flow model, as originally postulated, is mainly that it did not tell us enough. The flow of communication in a mass audience is far more complicated than two steps. What is known about the mass communication process is too detailed to be expressed in one sentence or in two steps. Nevertheless, two intellectual benefits from the two-step flow hypothesis are evident in communication research: (1) a focus upon opinion leadership, and (2) several revisions of the two-step flow, such as the one-step and multistep flow.

Homophily-Heterophily and the Flow of Communication

One's understanding of the nature of communication flows through interpersonal networks can be enhanced by the concepts of homophily and heterophily. The nature of *who* relays messages to *whom* is brought out in such network analysis.

Homophily-Heterophily

A fundamental principle of human communication is that the transfer of ideas occurs most frequently between individuals who are alike, or homophilous. Homophily is the degree to which pairs of individuals who interact are similar in certain attributes, such as beliefs, education, social status, and the like. Although a conceptual label—homophily—was assigned to this phenomenon only in fairly recent years by Lazarsfeld and Merton (1964, p. 23), the existence of homophilous behavior was noted a half-century ago by Tarde (1903, p. 64): "Social relations, I repeat, are much closer between individuals who resemble each other in occupation and education."

Homophily occurs so frequently because communication is more effective when source and receiver are homophilous. Such effective communication is rewarding to those involved in it. When two individuals share common meanings, beliefs, and a mutual language, communication between them is more likely to be effective. Most individuals enjoy the comfort of interacting with others who are quite similar. Talking with those who are quite different from ourselves requires more effort to make communication effective. Heterophilous communication may cause cognitive dissonance because an individual is exposed to messages that are inconsistent with existing beliefs, causing an uncomfortable psychological state. Homophily and effective communication breed each other. The more communication there is between members of a dyad, the more likely they are to become homophilous;* the more homophilous they are, the more likely it is that their communication will be effective. Individuals who break the homophily boundary and attempt to communicate with others who are different from themselves face the frustration of ineffective communication. Differences in technical competence, social status, and beliefs all contribute to heterophily in language and meaning, thereby leading to messages that go unheeded.

But heterophilous communication has a special informational potential, even though it may be realized only rarely. As we shall explain in a later section, heterophilous network links often connect two cliques, spanning two sets of socially dissimilar individuals. These interpersonal links are especially important in carrying information about innovations, as is implied in Granovetter's (1973) theory of "the-strength-of-weak-ties," so homophilous communication may be frequent and easy but may not be so crucial as the less frequent heterophilous communication in diffusing innovations.

Homophily as a Barrier to Diffusion

Homophily can act as an invisible barrier to the flow of innovations within a system. New ideas usually enter a system through higher status and more innovative members. A high degree of homophily means that these elite individuals interact mainly with each other, and the innovation does not "trickle down" to non-elites. Homophilous diffusion patterns cause new ideas to spread horizontally, rather than vertically, within a system. Homophily therefore acts to slow down the rate of diffusion. One implication of homophily as a barrier to dif-

* Although similarities in static variables like age and other demographic characteristics obviously cannot be explained as the result of communication leading to increased homogeneity.

fusion is that change agents should work with different sets of opinion leaders throughout the social structure. If a system were characterized by extreme heterophily, a change agent could concentrate his or her efforts on only one or a few opinion leaders near the top in social status and innovativeness.

Available evidence suggests Generalization 8-1: *Interpersonal diffusion networks are mostly homophilous.* For instance, seldom do those of highest status in a system interact directly with those of lowest status. Likewise, innovators seldom converse with laggards. Although this homophily pattern in interpersonal diffusion acts to slow the diffusion of innovations within a system, it may also have some benefits. For example, a high-status opinion leader might be an inappropriate role model for someone of lower status, so interaction between them might not be beneficial to the latter. An illustration of this point comes from an investigation by van den Ban (1963) in a Netherlands agricultural community. He found that only 3 percent of the opinion leaders had farms smaller than fifty acres in size, but 38 percent of all farms in the community were smaller than fifty acres. The wisest farm management decision for the large farmers was to purchase mechanized farm equipment, such as tractors and milking machines, as a substitute for hired labor. The best economic choice for those on the smaller farms, however, was to ignore the expensive equipment and concentrate on horticultural farming. As might be expected, however, the small farmers were following the example of the opinion leaders on the large farms, even though the example was inappropriate for their situation. In this case a high degree of homophily, in which small farmers would interact mainly with opinion leaders who were themselves small farmers, would probably be beneficial.

An illustration of homophilous and heterophilous diffusion networks is provided by Rao and Rogers' (1980) study in two Indian villages. One village was very innovative, and the other village was quite traditional. Diffusion networks for a new rice variety were more homophilous in the traditional village, as we would expect. The opinion leaders here were elderly and had little education. In comparison, the opinion leaders in the innovative village were younger, highly educated, and high in social caste. Each Indian belongs to a caste, a social position fixed by traditional occupation and religious sanctions. In the more traditional village, diffusion networks links were highly homophilous on caste. But in the progressive village, the rice variety innovation started at the top of the social structure and spread

downward across the caste lines through heterophilous network links.

Now we look at a series of generalizations that specify characteristics of leaders and followers when a certain degree of heterophily occurs.

Generalization 8-2: *When interpersonal diffusion networks are heterophilous, followers seek opinion leaders of higher socioeconomic status.*

Generalization 8-3: *When interpersonal diffusion networks are heterophilous, followers seek opinion leaders with more education.*

Generalization 8-4: *When interpersonal diffusion networks are heterophilous, followers seek opinion leaders with greater mass media exposure.*

Generalization 8-5: *When interpersonal diffusion networks are heterophilous, followers seek opinion leaders who are more cosmopolite.*

Generalization 8-6: *When interpersonal diffusion networks are heterophilous, followers seek opinion leaders with greater change agent contact.*

Generalization 8-7: *When interpersonal diffusion networks are heterophilous, followers seek opinion leaders who are more innovative.*

These six generalizations indicate a tendency for followers to seek information and advice from opinion leaders who are perceived as more technically competent than themselves. When heterophily occurs, it is usually in the direction of greater competency, but not *too* much greater. But we should not forget that the general pattern is one of homophily in interpersonal diffusion. This homophily means that the dyadic followers of opinion leaders usually learn appropriate lessons about innovations through their ties with their near-peer opinion leaders. But these homophilous diffusion networks also slow the percolation of an innovation through the structure of a social system.

Measuring Opinion Leadership and Network Links

Four main methods of measuring opinion leadership and diffusion networks links have been used in past research: (1) sociometric, (2) informants' ratings, (3) self-designating techniques, and (4) observations (Table 8-1).

Table 8–1. Advantages and Limitations of Four Methods of Measuring Opinion Leadership and Diffusion Networks.

Measurement Method	Description	Questions Asked	Advantages	Limitations
1. Sociometric method	Ask system members to whom they go for advice and information about an idea	Who is your leader?	Sociometric questions are easy to administer and are adaptable to different types of settings and issues. Highest validity	Analysis of sociometric data is often complex. Requires a large number of respondents to locate a small number of opinion leaders. Not applicable to sample designs where only a portion of the social system is interviewed.
2. Informants' ratings	Subjectively selected key informants in a social system are asked to designate opinion leaders	Who are the leaders in this social system?	A cost-saving and time-saving method as compared to the sociometric method	Each informant must be thoroughly familiar with the system.
3. Self-designating method	Ask each respondent a series of questions to determine the degree to which he/she perceives himself/herself to be an opinion leader	Are you a leader in this social system?	Measures the individual's perceptions of his opinion leadership, which influence his behavior	Dependent upon the accuracy with which respondents can identify and report their self-images.
4. Observation	Identify and record communication network links as they occur	None	Unquestioned validity	Obtrusive, works best in a very small system, and may require much patience by the observer.

The sociometric method consists of asking respondents whom they sought (or hypothetically might seek) for information or advice about a given topic, such as an innovation. Opinion leaders are those members of a system who receive the greatest number of sociometric choices (that is, who are involved in the largest number of network links). Undoubtedly, the sociometric technique is a highly valid measure of opinion leadership, as it is measured through the eyes of the followers. It necessitates, however, interrogating a large number of respondents in order to locate a small number of opinion leaders. And the sociometric method is most applicable to a sampling design in which all members of a social system are interviewed, rather than where a small sample within a large population is contacted.*

It is common to specify the number of sociometric partners that can be named by a respondent; for example, "Who are the *three* (or four, or five) other women in this village with whom you have discussed family-planning methods?" Such limited-choice questioning leads the respondent to name only her strongest network partners. It is possible that others with whom she converses less often may exchange information with the respondent that is most crucial in diffusing an innovation; in fact, Granovetter's (1973) "strength-of-weak-ties" theory (discussed later in this chapter) tells us that these less-frequent network partners may be particularly crucial in diffusion. So perhaps sociometric questions should allow an unlimited number of choices, letting the respondent name any number of partners with whom a topic is discussed. Another approach is to conduct a "roster study," in which each respondent is presented with a list of all the other members of the system, and asked whether he or she talks with each of them, and how often. The roster technique has the advantage of measuring "weak" as well as "strong" sociometric network partners.

An alternative to using sociometry to identify opinion leaders is to ask key informants who are especially knowledgeable about the communication networks in a system. Experience shows that often a handful of informants can identify the opinion leaders in a system, and almost as accurately as sociometric techniques, particularly when the system is small and the informants are well informed.

The self-designating technique asks respondents to indicate the

* Although it is possible to locate sociometric opinion leaders with survey sampling by means of snowball sampling in which an original sample of respondents in a system are interrogated. Then the individuals sociometrically designated by this sample are interviewed as a second sample, and so on (Rogers and Kincaid, 1981, pp. 109-110).

tendency for others to regard them as influential. A typical self-designating question is: "Do you think people come to you for information or advice more often than to others?" The self-designating method depends upon the accuracy with which respondents can identify and report their self-images. This measure of opinion leadership is especially appropriate when interrogating a random sample of respondents in a system, a sampling design that often precludes use of sociometric methods. An advantage of the self-designating technique is that it measures the individual's perceptions of his or her opinion leadership, which is actually what affects his or her behavior.

A fourth means of measuring opinion leadership is *observation,* in which an investigator identifies and records the communication behavior in a system. One advantage of observation is that the data usually have a high degree of validity. If network links are appropriately observed, there is little doubt about whether they occur or not. Observation works best in a very small system, where the observer can actually see and record interpersonal interaction as it happens. Unfortunately, in such small systems observation may be a very obtrusive data-gathering technique. Because the members of a system know they are being observed, they may act differently.* Further, an observer may need to be very patient if the diffusion network behavior that he or she wants to observe occurs only rarely.

In practice, observation is seldom used to measure diffusion networks and opinion leadership. By far the most popular means of measurement is survey sociometry.

When two or three types of opinion leadership operations have been used with the same respondents, positive correlations among the measures have been obtained, although these relationships are much less than perfect.* This finding suggests that the choice of any one of the four methods might be based on convenience, as all four are about equally valid.

Figure 8-1 shows a typical distribution of opinion leadership in a social system. A very few individuals receive a great deal of opinion

*Very unobtrusive methods of measuring network links may sometimes be used, where the data were often recorded for other purposes (Rogers and Kincaid, 1981, pp. 113-118). For example, a computer teleconferencing network (like Legitech described in the next chapter) leaves a computer record of who talks to whom, and what they said; these data can sometimes be accessed as an unobtrusive measure, with the permission of the respondents of course.

* Among these studies are Rogers and Burdge (1962) in Ohio, Rogers with Svenning (1969, pp. 224-225) in Colombia, and Sollie (1966) in Mississippi.

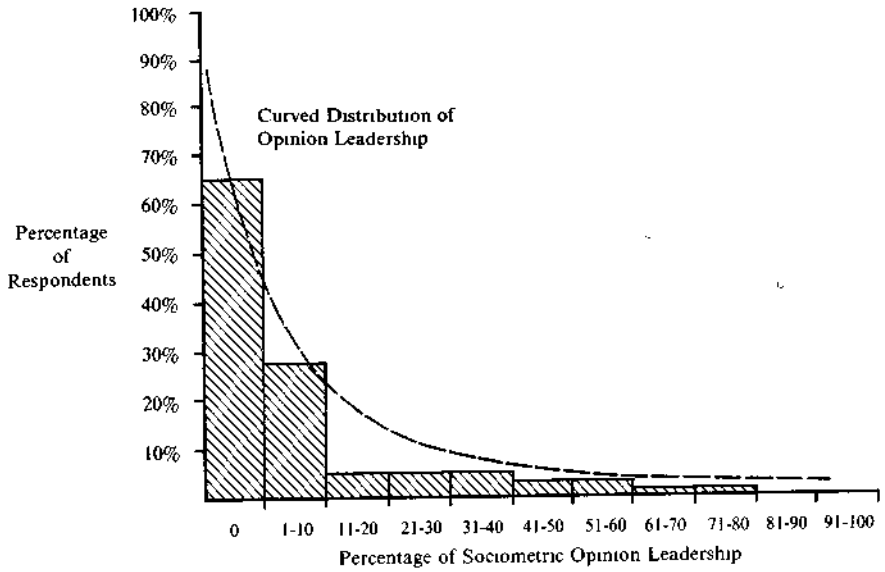

Figure 8–1. The distribution of sociometric opinion leadership is highly skewed with a few individuals having very high opinion leadership and many individuals having none.

A similarly skewed distribution of opinion leadership has been found in most social systems. These data were gathered from personal interviews with a sample of 1,142 Nigerian farmers in 17 villages in 1967. Most individuals (66 percent) received no sociometric choices as opinion leaders. At the other extreme, a very few individuals (1 percent) were sociometrically nominated by more than 71 percent of all the other individuals in their villages.

Source: Rogers et al (1970).

leadership, while most individuals have none. The most influential opinion leaders are key targets for the efforts of change agents.

Characteristics of Opinion Leaders

How do opinion leaders differ from their followers? The following generalizations summarize a considerable volume of empirical studies designed to answer this question. In each we refer to "opinion leaders" and "followers" as if opinion leadership were a dichotomy and as if nonleaders were all followers. These oversimplifications are necessary for the sake of clarity.

External Communication

Generalization 8-8: *Opinion leaders have greater exposure to mass media than their followers.* The original conception of the two-step flow hypothesis stated that opinion leaders attend more to mass media channels. One way in which opinion leaders gain their competency is by serving as an avenue for the entrance of new ideas into their social system. The linkage may be provided by mass media channels, by the leader's cosmopoliteness, or by the leader's greater change agent contact.

Generalization 8-9: *Opinion leaders are more cosmopolite than their followers.*

Generalization 8-10: *Opinion leaders have greater change agent contact than their followers* (Figure 8-2).

Accessibility

In order for opinion leaders to spread messages about an innovation, they must have interpersonal networks with their followers. Opinion leaders must be accessible. One indicant of such accessibility is social participation; face-to-face communication about new ideas occurs at meetings of formal organizations and through informal discussions.

Generalization 8-11: *Opinion leaders have greater social participation than their followers.* An illustration of this point is provided by the two key opinion leaders in the Solera diffusion network for solar panels (shown later in Figure 8-7).

Socioeconomic Status

We expect that a follower typically seeks an opinion leader of somewhat higher status than their own, as suggested in Generalization 8-2. So opinion leaders, on the average, should be of higher status. This point was stated by Tarde (1903, p. 221): "Invention can start from the lowest ranks of the people, but its extension depends upon the existence of some lofty social elevation." Generalization 8-12: *Opinion leaders have higher socioeconomic status than their followers.* Figure 8-2 shows this relationship for Brazilian farmers; the opinion leaders have much larger farms than their followers.

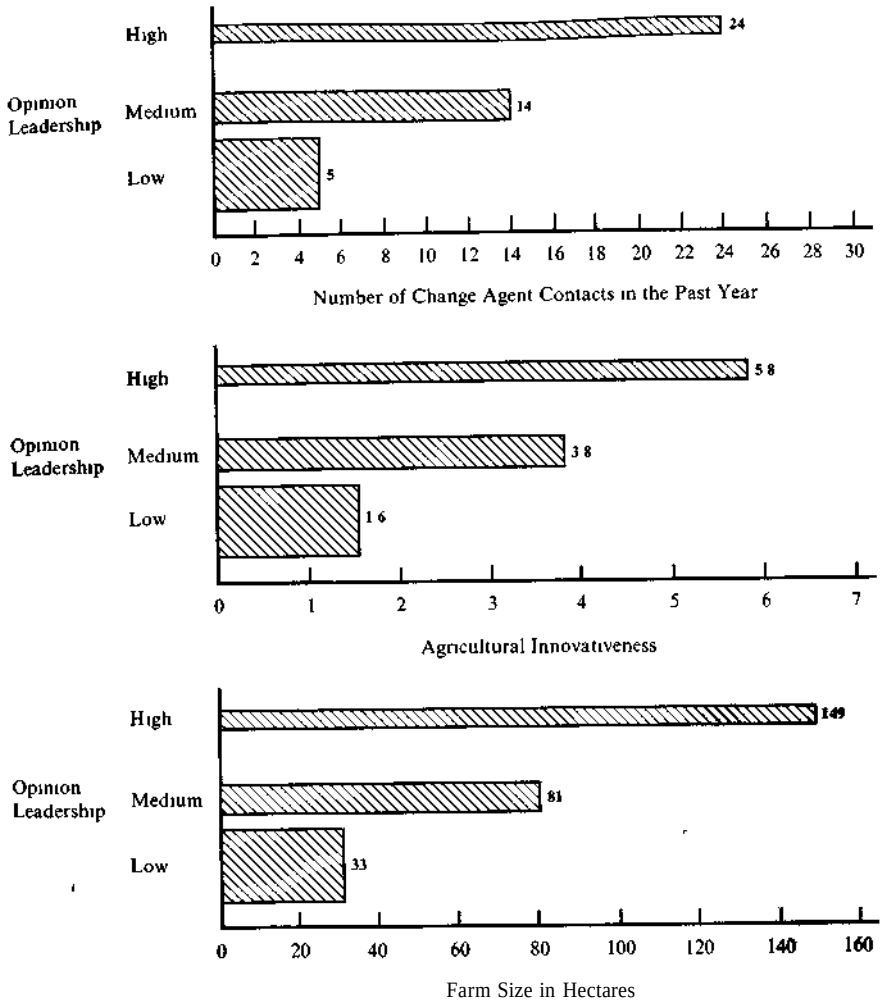

Figure 8-2. Opinion leaders have more change agent contact, higher agricultural innovativeness, and larger farm size, among Brazilian farmers.

These data come from personal interviews with 1,307 Brazilian farmers in 1966. Sociometric opinion leadership scores are divided into three categories here: (1) "High," 6 percent of the respondents with highest opinion leadership scores, (2) "Medium," the 16 percent of the respondents with some opinion leadership, and (3) "Low," the 78 percent of the Brazilian farmers with almost no opinion leadership.

Source Rogers et al (1970)

Innovativeness

If opinion leaders are to be recognized by their peers as competent experts about innovations, it is likely that they adopt new ideas before their followers. There is strong empirical support for Generalization 8-13: *Opinion leaders are more innovative than their followers* (Figure 8-2). The research findings do not indicate, however, that opinion leaders are necessarily innovators. Sometimes they are; sometimes they are not. At first glance, there appears to be contradictory evidence on whether opinion leaders are innovators. What explains this apparent paradox? We must consider the effect of system norms on the innovativeness of opinion leaders, because the degree to which opinion leaders are innovative depends in large part on their followers.

Innovativeness, Opinion Leadership, and System Norms

How can opinion leaders be most conforming to system norms and at the same time lead in the adoption of new ideas? The answer is expressed as Generalization 8-14: *When a social system's norms favor change, opinion leaders are more innovative, but when the norms do not favor change, opinion leaders are not especially innovative.* In systems with more traditional norms, the opinion leaders are usually a separate set of individuals from the innovators. The innovators are perceived with suspicion and often with disrespect by the members of such systems, who do not trust their sense of judgment about innovations. For instance, in a study of Colombian farmers, Rogers with Svenning (1969, pp. 230-231) found that opinion leaders in the relatively progressive villages were more innovative than their followers, but in the traditional villages the opinion leaders were only slightly more innovative than their followers and were older and less cosmopolite. So the system's norms determine whether or not opinion leaders are innovators.

Data from inquiries in various nations support the notion of opinion leaders as highly conforming to system norms. For instance, Herzog et al (1968, p. 72) concluded from their study of Brazilian villages that: "In most traditional communities, neither the leaders nor their followers are innovative, and as a result, the community remains traditional. In the most modern communities, community norms favor innovativeness and both the leaders and followers are innovative. In the middle range communities, where modernization is just getting underway, divisions occur and the community opinion leaders lead the way toward modernization, by trying new ideas before the other farmers in the community."

There is an important implication for change agents in the present generalization about opinion leader conformity to norms. A common error made by change agents is that they select opinion leaders who are too innovative. We point out in Chapter 9 that change agents work through opinion leaders in order to close the heterophily gap with their clients. But if opinion leaders are too much more innovative than the average client, the heterophily that formerly existed between the change agent and his or her clients now exists between the opinion leaders and their followers. Innovators are poor opinion leaders in systems with traditional norms: they are too elite and too change oriented. The innovator serves as an unrealistic model for the average client, and he or she knows this. The adopter category of the opinion leaders in a system, then, depends on their position relative to the norms of the system.

A parallel case to that among farmer opinion leaders is found in the case of the former "laboratory schools" in the United States. These schools were usually affiliated with a college of education, located on a university campus, and used for the introduction and trial of new teaching methods. The typical lab school had almost unlimited funds, and its student body was composed of bright faculty children. Supposedly, the lab school was an attempt to demonstrate educational innovations that would then spread to other schools. But the lab schools, with their enriched environments and talented students, were perceived as too heterophilous by the average school. Visiting teachers and administrators would come to the lab schools, impelled by curiosity, but would go away unconvinced by the innovations they had observed. As a result, laboratory schools throughout the United States have fallen into disrepute as a means of diffusion, and almost all of them have been terminated in recent years. They were failures as demonstrations of educational innovations.

Sometimes change agents identify potentially effective opinion leaders among their clients, but they concentrate their contacts too much on these leaders, who soon become innovators and lose their former following. The respect relationship between opinion leaders and their followers is a rather delicate balance. If an opinion leader becomes too innovative, or adopts a new idea too quickly, his or her followers may begin to doubt the opinion leaders' judgment. One role

of the opinion leader in a social system is to help reduce the uncertainty about an innovation for his or her followers. To fulfill this role, the opinion leader should demonstrate prudent judgment in his or her decisions to adopt new ideas. So the innovator must continually look over his or her shoulder, and consider where the rest of his or her system is at.

The opinion leaders' influence in a social system may vary not only on the basis of his or her innovativeness relative to the norms of the system, but also on the basis of the nature of the innovation that is diffusing. An interesting illustration of the role of opinion leaders in the diffusion of a high-uncertainty and a low-uncertainty innovation is provided by Becker's (1970b) survey of ninety-five directors of local health departments in three states. The low-uncertainty innovation was a measles immunization program, a new idea that fit easily with the purposes of health departments and that was compatible with the professional norms of the directors of the health departments (who are medical doctors). The measles immunization program spread quickly among the ninety-five health departments. The innovators in adopting this new program were the opinion leaders among the ninety-five health department directors (in other words, the behavior of the opinion leaders served to speed up the diffusion process).

The high-uncertainty innovation was diabetes screening, a program that was a radical departure from the usual activities of public health departments. This innovation was socially risky because it infringed upon an activity usually performed by medical doctors in private practice (screening for chronic diseases). So this innovation did not fit with the norms of the system. The innovators in adopting this innovation were not opinion leaders; instead they were the directors of health departments whom their peers rated as socially marginal. The opinion leaders knew about this innovation, but they waited to adopt. Once these innovators had implemented the innovation of diabetes screening and found that its social risks were not excessive, the opinion leaders adopted. The innovation of diabetes screening then diffused fairly rapidly, but only after an initially slow start.

Becker (1970b) interpreted his findings to mean that the time at which an individual adopts an innovation depends on whether the individual is an opinion leader or not. Normally innovative individuals might hold back in adopting a high-uncertainty innovation in order to maintain or to increase their opinion leadership.

The Becker (1970b) investigation of health department directors is distinctive in that the respondents were heads of organizations. Can organizations have opinion leadership, as individuals do? A study by Walker (1966) suggests that innovations can diffuse from organization to organization through interorganizational networks, in a parallel process to that among individuals in a social system.* The organizations studied by Professor Walker were the fifty state governments in America. Each state was scored on its innovativeness on the basis of when it adopted (by enacting a state law) each of eighty-eight state programs in welfare, health, education, conservation, highways, civil rights, police, and the like. Each adoption by a state amounted to offering a new service, establishing a new regulation, or creating a new agency. Examples are having a gasoline tax, enacting a civil rights bill, providing for slaughterhouse inspection, and having a state health board. The five most innovative states, Walker (1971, p. 358) found, were New York, Massachusetts, California, New Jersey, and Michigan. At the bottom of Walker's list was Mississippi. The pioneering states, which Professor Walker called "the national league," have large populations and are urbanized and industrialized. Perhaps they faced social problems some years before the more rural smaller states, and enacted new types of laws in order to cope with these problems.

In each region of the United States, certain states emerged as opinion leaders; once they adopted a new program, other states in their region followed along. If an innovation was first adopted by other than one of these regional opinion leader states, it then spread to the other states slowly or not at all. Thus, a communication structure seemed to exist for innovation diffusion among the states.

In a further analysis, Walker (1971) gathered sociometric data from personal interviews with state officials in ten states to determine the actual patterns of opinion leadership and diffusion networks among the American states. State officials looked to their immediate neighbors when searching for information about innovations: "State administrators communicate most readily with their counterparts in states that they believe have similar resources, social problems, and administrative styles" (Walker, 1971, p. 381). For instance, Iowa officials followed Michigan's and California's lead in certain innovations, although they were much more influenced by Wisconsin, a

*The publications bearing on the Walker study of innovativeness among the U.S. states are Walker (1966, 1971, 1973) and Gray (1973a, 1973b).

bordering state to Iowa that was considered a more appropriate model. Wisconsin ranked tenth on Walker's index of innovativeness; Iowa ranked twenty-ninth.

In summary, one can think of the diffusion process among the fifty American states as beginning with a new law that is adopted by one or more of the five "national league" states, which after a few years may be adopted by one of the regional opinion leader states. Then the new law spreads rapidly among the surrounding states in the region. Notice that the opinion leader states generally mediated between the five innovators and the other forty-five states. They provided interconnectedness to the nationwide diffusion network. Here we are beginning to look at more than just the characteristics of opinion leaders versus followers. We have taken the next step toward gaining an improved understanding of diffusion networks.

Monomorphic and Polymorphic Opinion Leadership

Is there one set of all-purpose opinion leaders in a system, or are there different opinion leaders for each issue? *Polymorphism* is the degree to which an individual acts as an opinion leader for a variety of topics. Its opposite, *monomorphism,* is the tendency for an individual to act as an opinion leader for only a single topic. The degree of polymorphic opinion leadership in a given social system seems to vary with such factors as the diversity of the topics on which opinion leadership is measured, whether system norms are progressive or not, and so on. An analysis of opinion leadership among housewives in Decatur, Illinois, for four different topics (fashions, movies, public affairs, and consumer products) by Katz and Lazarsfeld (1955, p. 334) found that one-third of the opinion leaders exerted their influence in more than one of the four areas. Other studies report more, or less, polymorphism.

Peer Networks in the Diffusion of a Medical Drug

It was an easy step for diffusion scholars to count the number of network links for each individual in a social system, in order to measure their degree of opinion leadership, and then to determine the characteristics of opinion leaders and followers. But this was still just a type of investigation in which individuals were the units of analysis (even though the variable of opinion

leadership was measured for individuals as the number of interpersonal choices they received). The next step was to begin using the diffusion network links as units of analysis. Such network analysis would allow deeper understanding of the previously hidden mechanics of the diffusion process.

The first diffusion investigation" to research the nature of diffusion networks was the classic study of a new drug's spread among doctors (Coleman et al, 1966), which we have mentioned in other chapters. What set this splendid investigation apart from the several hundred other diffusion studies that had been completed prior to it was the insightful way in which Professor James Coleman and his colleagues investigated the interpersonal networks that actually impel the diffusion process. Like most previous diffusion scholars, Coleman et al first studied various independent variables related to individual innovativeness (the date of adoption of the new drug, gammanym). Unlike most previous scholars, however, Coleman and his coresearchers included various indicators of network communication behavior among their independent variables of study; they found these network variables to be the most important predictors of innovativeness (that is, more important than such individual characteristics as age, cosmopoliteness, and socioeconomic status), as we shall detail shortly.

But Coleman et al (1966) did not stop there, as previous diffusion researchers had done. Instead, they proceeded to study the way in which interpersonal networks explained the very nature of the diffusion process. In this way, the Colombia University scholars departed from the previous reliance of diffusion scholars on the individual as the unit of analysis; they pioneered in using the network links as their units of data analysis. This methodological advance allowed Coleman et al to gain important understandings into the interpersonal mechanism causing the S-shaped diffusion curve. Their work stands out as a model for gaining in-depth insight into the nature of diffusion, and their approach has attracted the later attention of various other diffusion scholars who have probed the dynamics of diffusion networks.

For this reason, we describe the methodology and findings of the drug study in some detail here, especially illustrating how Coleman et al studied diffusion networks.

First, it is important to point out that gammanym was a powerful drug and one that was widely used in the treatment of acute conditions. So the innovation had a potential for almost daily use by a physician in general practice. Gammanym's efficacy in any particular case could be quickly and easily determined. The new drug seemed to be the approximate equivalent for doctors of what hybrid corn meant to Iowa farmers: a major change in previous behavior, whose results (in terms of relative advantage) were strikingly evident. Only two months after the drug became available, 15 percent of the doctors tried it, and four months later this figure reached 50 percent (Coleman et al, 1966, p. 25). Undoubtedly, the nature of gammanym affected its

rapid rate of adoption, and tended to emphasize the importance of peer networks in its diffusion. Although there was a high degree of uncertainty in a doctor's first use of the new drug, its results were strikingly positive and almost all of the network messages about the innovation encouraged other doctors to adopt. Almost no discontinuance of gammanym occurred during the seventeen-month period of its diffusion.

In many respects, gammanym was an ideal innovation to trace as it spread through diffusion networks in the medical community. Coleman et al (1966) constructed a measure of *interconnectedness,* the degree to which the units in a social system are linked by interpersonal networks. Generalization 8-15 states that: *The interconnectedness of an individual in a social system is positively related to the individual's innovativeness.* The logic for this generalization is fairly obvious. If individuals are convinced to adopt new ideas in part by the experience of near-peers with the innovation, then the more interpersonal communication that an individual has with such near-peers, the relatively earlier he or she should be in adopting a new idea.

Empirical evidence from a variety of diffusion network studies* supports this generalization, that originated in the medical drug study. Coleman et al (1966, pp. 79-92) found that innovativeness in adopting the new drug was associated with several measures of interconnectedness for their sample of medical doctors:

1. Affiliation with a hospital as a regular staff member.
2. More regular attendance at hospital staff meetings.
3. Sharing an office with one or more other doctors.
4. Being named as a source of information and advice by other doctors.
5. Being named by other doctors as someone with whom they discussed their patients' cases.
6. Being named as a best friend by other doctors.
7. Reciprocating the sociometric network links reported by other doctors who chose them as discussion partners.

On each of three sociometric questions, doctors with more network links were the most innovative in adopting gammanym, while doctors who were isolates (that is, who received no sociometric choices from their peers) were latest in adopting the new drug (Figure 8-3).* In fact, the degree of network interconnectedness of a physician was a better predictor of his or her innovativeness than any of the other independent variables investigated by Coleman et al (1966, p. 89), such as a doctor's personal characteristics, exposure to communication channels, patients' incomes, and the like. It seemed that the "between-people" variables were more important than the "within-people" variables. Among the various network connectedness measures, the best predictor of innovativeness was the friendship variable (the sixth variable in the above list); in fact, more than half of the forty-six isolate doctors (who received only one or no friendship sociometric choices, and who practiced medicine alone rather than in an office partnership) had still not adopted the new drug ten months after it began to diffuse in the medical community (Coleman et al, 1966, p. 90). In comparison, at this same ten-month point, almost all of the interconnected doctors (who received two or more network choices) had adopted gammanym.

*For example, Rogers and Kincaid (1981), Lee (1977), and Hong (1976).

* Similar evidence that network isolates are less innovative than nonisolates is provided by Rogers and Kincaid's (1973, p. 224) study of the diffusion of family planning among 1,025 Korean women. The isolates were only about one-fourth as likely to adopt contraceptive methods in these Korean villages as were the nonisolates. The isolate versus nonisolate dichotomy is a crude measure of the concept of interconnectedness.

Coleman et al (1966, pp. 95-112) explained the greater innovativeness of the interconnected doctors on the basis of a chain-reaction kind of contagion process that seemed to take place during the early months of the diffusion

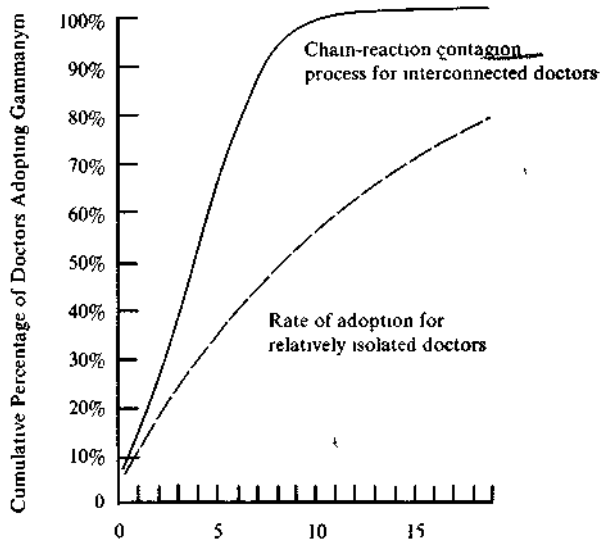

Figure 8-3. The rate of adoption for interconnected doctors "took off' in a snowballing contagion process, while the rate of adoption for relatively isolated doctors approached a straight line.

The present rates of adoption are a generalized and somewhat stylized version of the actual rates of adoption of gammanym reported by Coleman et al (1966, p. 89) for interconnected versus isolated doctors, when this categorization was made for each of a variety of sociometric measures. The chain-reaction contagion process occurs for interconnected doctors because they are closely linked by communication networks.

Source: Based upon Coleman et al (1966, p. 89)

process for gammanym. Figure 8-3 shows a stylized rate of adoption for the interconnected versus the isolated doctors, which is based on the general results of plotting actual adoption rates for the interconnected and isolated physicians for various sociometric measures (such as friendship, the discussion of patient cases, and office partnerships). It can be observed in Figure 8-3 that the s-curve for the interconnected doctors takes off rapidly in a kind of snowballing process in which an innovator conveys his or her personal experience with the innovation to two or more of his or her peers, who each may then adopt and, in the next time period, interpersonally convey their personal experience with the new idea to two or more other doctors, and so on. Within several months, almost all of the interconnected doctors have adopted and their rate of adoption then necessarily begins to level off. This contagion process occurs because of the interpersonal networks that link the individuals, thus providing communication avenues for the exchange of evaluative information about the innovation.

The chain-reaction snowballing of adoption does not happen, however, for the relatively isolated individuals, who lack peer-network contacts from which to learn about their subjective evaluations of the innovation. So the isolated individuals' rate of adoption is almost a straight line, curving slightly because the number of new adopters in each period remains a constant percentage of those who have not already adopted the innovation (Figure 8-3). There is no sudden take-off in the rate of adoption for the isolated individuals. But eventually most or all of these isolated individuals will adopt; this is not shown in Figure 8-3 because Coleman et al (1966) conducted their data gathering in the seventeenth month after the release of gammanym, when only about 75 percent of their isolated doctors had adopted the drug.

In other words, interconnected doctors were more innovative in adopting gammanym mainly because their rate of adoption was shaped differently from the rate of adoption for more isolated doctors. Thanks to their interpersonal networks, interconnected individuals have a faster trajectory to their S-shaped diffusion curve; hence, on the average they are more innovative than the isolated doctors whose rate of adoption is almost a straight line. Presumably, if the more isolated doctors had indeed been completely isolated, they would have adopted even more slowly, if at all. "The impact [of networks] upon the integrated doctors was quick and strong; the impact upon isolated doctors was slower and weaker, but not absent" (Coleman et "al, 1966, p. 126).

When the doctors were confronted with making a decision about the new drug in an ambiguous situation that did not speak for itself, they turned to each other for information that would help them make sense out of the new stimulus. Doctors who are closely linked in networks tend to interpret the innovation similarly. In the case of gammanym, the medical community studied by Coleman et al (1966, p. 119) gradually arrived at a positive perception of the innovation. This shared opinion led the interconnected doctors to adopt the new drug rapidly, and eventually the medical community's favorable view of the innovation trickled out to the relatively isolated doctors on the social margins of the network.

Thus, one can think of a social system as going through a gradual learning process regarding an innovation, as the aggregated experience of the individuals with the new idea builds up and is shared among them through interpersonal networks.

What were the actual contents of the network messages exchanged among the medical doctors about gammanym? Coleman et al (1966) did not find out, unfortunately. They speculate that the doctors may have talked about the drug's existence, its price, its efficacy as a cure, or about the occurrence of undesirable side effects: "Perhaps Dr. A, who had used the drug, advised Dr. B to do likewise; perhaps Dr. B copied Dr. A without being told; perhaps Drs. A and B made a joint decision" (Coleman et al, 1966, pp. 111-112). Future research needs to investigate the content of interpersonal messages about an innovation; the usual methodology of diffusion research and of communication network analysis does not provide feasible means of obtaining such network message content (Rogers and Kincaid, 1981). But appropriate techniques of study could easily be devised to capture these previously invisible message contents.

Diffusion Networks

As we have just shown, the heart of the diffusion process is the modeling and imitation by potential adopters of their near-peers who have previously adopted a new idea. In deciding whether or not to adopt an innovation, we all depend mainly on the communicated experience of others much like ourselves who have already adopted. These subjective evaluations of an innovation mainly flow through interpersonal networks. For this reason, we must understand the nature of networks if we are to comprehend the diffusion of innovations fully.

Networks can serve as important connections to information resources, as the following examples (provided by Johnson and Browning, 1979) imply:

- A public relations executive receives a phone call from the owner of an airport where he occasionally rents hot air balloons. The owner is interested in contacting movie actor Jerry Lewis to donate balloon rides for the Lewis annual telethon; he has heard that the executive knows Lewis. . . .

- A lobbyist for a multinational corporation learns that his company needs to contact one of its employees who is somewhere in the Middle East. The lobbyist calls an acquaintance in the Middle East desk of the U.S. Department of State; the employee is located the next day. . . .
- A University of Pennsylvania faculty member has a friend whose brother was hurt in an automobile accident in southern Mexico; because the brother was at fault in the accident, the friend's parents have not been able to arrange with the Mexican police for him to be moved to a hospital where he can receive adequate care. The professor calls his cousin, a surgeon in San Antonio, who then calls a doctor he met at a conference in Mexico City. This doctor, in turn, calls a doctor he knows in the southern Mexico province. The brother is flown home to the U.S. in a few hours.

So networks are the invisible routes through which individuals make things happen. Now, how do we understand them?

Communication Network Analysis

In very recent years, important advances have been made in methods of investigating communication networks and in theorizing about them (Rogers and Kincaid, 1981). What is a communication network? A *communication network* consists of interconnected individuals who are linked by patterned flows of information. The point here is that networks have a certain degree of structure, of stability. It is this patterned aspect of networks that provides predictability to human behavior. The study of networks helps illuminate *communication structure,* the differentiated elements that can be recognized in the patterned communication flows in a system. This structure consists of the cliques and their interconnections (through liaisons and bridges).

The communication structure is so complex in any but a very small system that even the members of a social system usually do not understand the communication structure of which they are a part. This is because there are so many possible network links in a system, causing a problem of information overload for the individual who tries to detect the communication structure. For instance, in a social system with 100 members, 4,950 links are possible (computed by the formula $\frac{N(N-1)}{2}$ where N is the number of individuals in the system). In a

system of 200 members, 19,900 links are possible; with 1,000 members, almost a half-million links are possible. Obviously, a computer is necessary to analyze the patterns among these myriad of network links. *Communication network analysis* is a method of research for identifying the communication structure in a system, in which relational data about communication flows are analyzed by using some type of interpersonal relationships as the units of analysis.

Methods of network analysis put individuals in cliques on the basis of their proximity in network links, so that individuals who are closer are assigned to the same clique. *Communication proximity* is the degree to which two linked individuals in a network have personal communication networks that overlap (Figure 8-4). *A personal communication network* consists of those interconnected individuals who are linked by patterned communication flows to a given individual. One can think of each individual possessing such a personal network, consisting of the set of other individuals to whom the focal individual is linked in network relationships. The focal individual's behavior is determined, in part, by information and influence that is communicated through the individual's personal network.

Some personal networks consist of a set of individuals who interact with each other; these are *interlocking personal networks.* In contrast, *radial personal networks* consist of a set of individuals who do not interact with each other. Such radial personal networks are more open,* and thus allow the focal individual to exchange information with a wider environment. Obviously, such radial networks are particularly important in the diffusion of innovations because their links reach out into the entire system, while an interlocking network is more ingrown in nature.

The-Strength-of- Weak-Ties

The notion of classifying network links on the basis of the degree to which they convey information began with Granovetter's (1973) theory of "the-strength-of-weak-ties." This network scholar sought to determine how people living in the Boston suburb of Newton got jobs. Granovetter gathered data from a sample of 282 respondents who had taken a new job within the past year. To his complete surprise, most of these individuals heard about their positions from

* *Openness* is the degree to which a unit exchanges information with its environment.

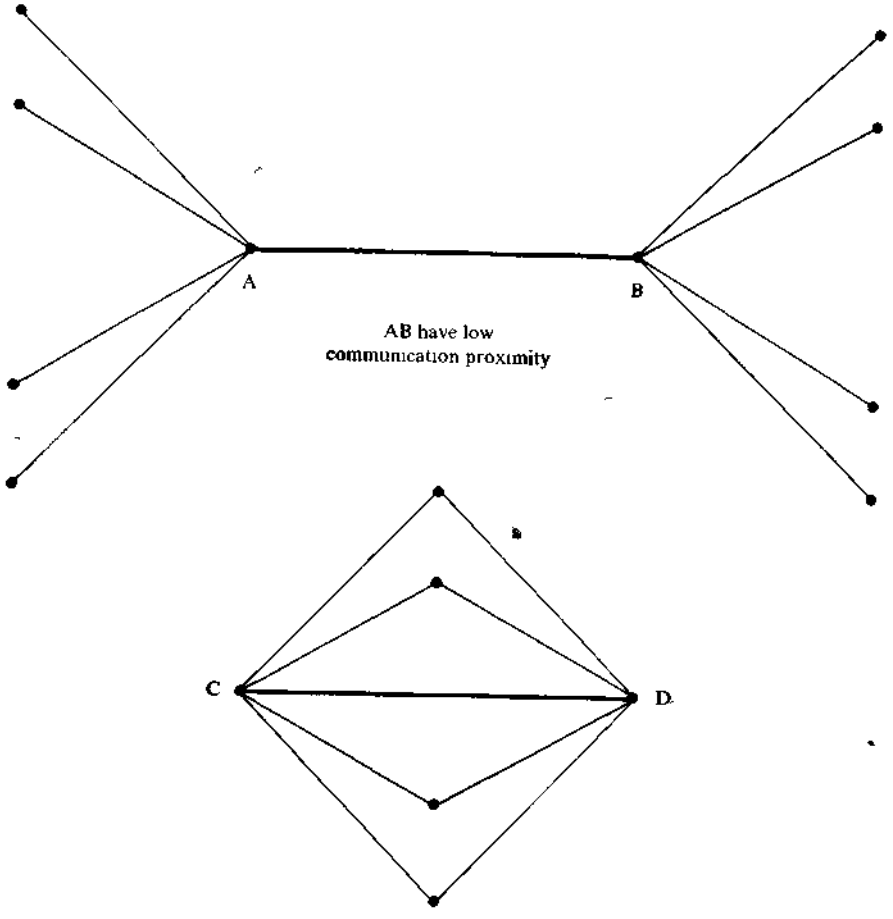

Figure 8-4. Communication proximity is the degree to which two individuals have overlapping personal communication networks.

Both pairs of individuals A-B and C-D have direct communication, but C-D are more proximate because they are also connected by four indirect links. In other words, individuals C and D have personal communication networks that overlap, while A and B do not. This means that C-D are more likely to exchange information than are A-B. Communication proximity is the basis for assigning individuals to cliques, and thus is the criterion for determining the communication structure of a system.

Source: Adopted from Alba and Kadushin (1976).

heterophilous individuals who were not very close friends. These "weak ties" occurred with individuals "only marginally included in the current network of contacts, such as an old college friend or a former workmate or employer, with whom sporadic contact had been maintained"(Granovetter, 1973). Chance meetings with such acquaintances sometimes reactivated these weak ties, leading to the exchange of job information with the individual.

Only 17 percent of Granovetter's Newton respondents said they found their new job through close friends or relatives.* Why were weak ties so much more important than strong network links? Because an individual's close friends seldom know much that the individual does not also know. One's intimate friends are usually friends of each other's, forming a close-knit clique; such an ingrown system is an extremely poor net in which to catch new information fron one's environment. Much more useful as a channel for gaining such information are an individual's more distant acquaintances; they are more likely to possess information that the individual does not already possess, such as about a new job or about an innovation. Weak ties connect an individual's small clique of intimate friends with another, distant clique; as such, it is the weak ties that provide interconnectedness to a total system. The weak ties are often bridging links,* connecting two or more cliques. If these weak ties were somehow removed from a system, the result would be an unconnected set of separate cliques. So even though the weak ties are not a frequent path for the flow of communication, the information that does flow through them plays a crucial role for individuals and for the system. This great importance of weak ties in conveying new information is why Granovetter (1973) called his theory "the-[informational] strength-of-weak [network]-ties."

The weak-versus-strong-ties dimension is more correctly and precisely called *communication proximity,* defined previously as the degree to which two individuals in a network have personal communication networks that overlap. Figure 8-5 shows that weak ties are low in communication proximity. At least some degree of heterophily must be present in network links in order for the diffusion of innovations to occur, as we have shown previously in this chapter. The low-

* Similar evidence of the importance of weak ties in the diffusion of information about new jobs is provided by Langlois (1977), Lin et al (1981), and Friedkin (1980), but not by Murray et al (1981). An overall summary is provided by Granovetter (1980).

* A *bridge* is an individual who links two or more cliques in a system from his or her position as a member of one of the cliques.

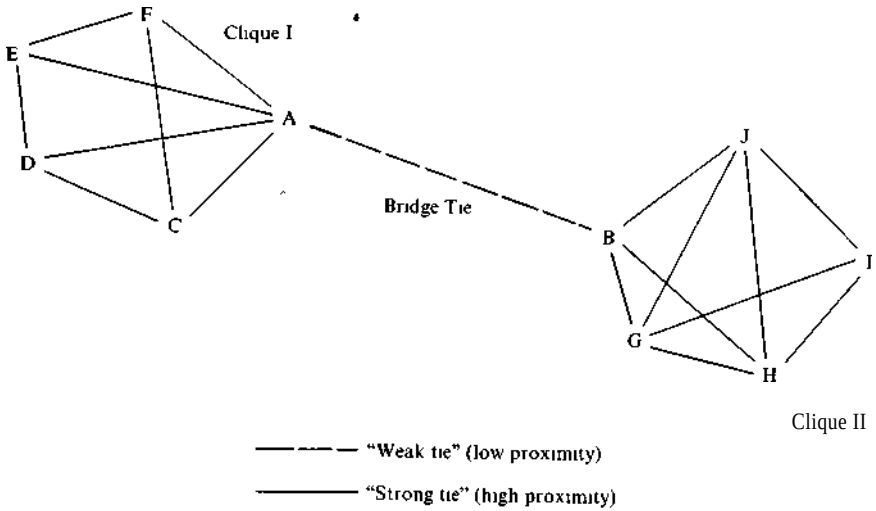

Figure 8-5. Low-proximity network links are important channels for the flow of information between cliques in a network.

Note that the bridge tie from individual A to individual B has low communication proximity because there is no overlap between the personal communication networks of individuals A and B. This communication link plays a crucial function in the flow of information in this network; if it were removed, the network would collapse into two unconnected cliques. According to Granovetter's (1973) theory of the-strength-of-weak-ties, the low-proximity A-B link is "strong" in its potential for carrying information between the two unalike cliques, thus playing a crucial role in the diffusion of innovativeness.

Source: Rogers and Kincaid (1981, p. 130), used by permission.

proximity weak ties are often heterophilous, and this is one reason for their central importance in the diffusion process. For example, Liu and Duff (1972) and Duff and Liu (1975) found that a family planning innovation spread rather quickly among the members of small cliques of Filippino housewives. But this new idea did not diffuse throughout the total community until weak ties conveyed information about the contraceptive from one tight-knit clique to another. The weak ties were usually heterophilous on socioeconomic status, linking, for example, a high-status clique with a lower-status clique.

We summarize this discussion with Generalization 8-16: *The information-exchange potential of communication network links is negatively related to their degree of(1) communication proximity, and*

(2) homophily. * Heterophilous links of low proximity (Granovetter's "weak ties"), while rare, seem to play a crucial role in the flow of *information* about an innovation. This information may be *influential* if it consists of a personal evaluation of an innovation by someone who has already adopted it. In the case of diffusion, it is often rather difficult to distinguish between information and influence because many of the informative messages that are conveyed interpersonally are also high in their potential to change behavior.

But it is possible that while there is a strength-of-weak-ties in networks that convey information about an innovation, there may also be a "strength-*of-strong-ties"* in networks that convey interpersonal influence. Certainly we would expect that the influence potential of network ties with an individual's intimate friends in his or her personal network would be stronger than the opportunity for influence from an individual's "weak ties" with seldom-contacted acquaintances. Note that we are talking about *potential* influence here, not *actual* influence. One's closely linked peers in an interlocking network seldom exert their potential influence because this type of homophilous, high-proximity personal network is seldom activated by information about innovations. One's intimates rarely possess much information that one does not already know. Information must flow into such an interlocking network to provide energy for further information exchange.

The reader should remember that very few investigations have been conducted to date on the strength-of-weak-ties theory as it applies to the diffusion of innovations. So Generalization 8-16 should be regarded as somewhat tentative at present. Perhaps there are diffusion situations in which a strength-of-strong-ties may occur.

Who Is Linked to Whom in Networks?

We have shown throughout this book that networks play a very crucial role in diffusion. Now we explore the issue of who is linked to whom in these networks. Generalization 8-17 states: *Individuals tend to be linked to others who are close to them in physical distance and*

*In addition to the support for this generalization provided by the Liu and Duff (1972) and the Duff and Liu (1975) study in the Philippines, the research by Rogers and Kincaid (1981) on diffusion networks for family planning in Korea also supports Generalization 8-16.

who are relatively homophilous in social characteristics. * If everything else is equal, individuals form network links that require the least effort and that are most rewarding. So both spatial and social proximity can be interpreted as indicators of least effort. Communication network links with neighboring and homophilous partners are relatively easy and require less effort. But such low-effort network links are usually of limited value for obtaining information (as we argued in the previous section). In contrast, heterophilous links with socially and spatially distant others are usually stronger in carrying useful information to an individual. Easy networks, thus, are least valuable informationally.

The implication for individuals in managing their personal networks, if they wish to improve their reception of information, is to break out of the comfortability of close links in the direction of more heterophilous and spatially distant network links.

Network Structure and Solar Diffusion in a California Neighborhood*

At the time of the Arab oil embargo in 1973, there were fewer than one hundred solar homes in the United States. By 1982, this number approached 400,000 households, or about 1 percent of the total U.S. population. California leads the nation in the rate of adoption of solar, with about 5 percent of homeowners adopting. Here we present data for a small California neighborhood, "Solera," in which seven of the forty-four homes (about 16 percent) have adopted this innovation. Solera thus represents an atypical situation in its rate of solar adoption. But it is a useful illustration of the microanalysis of diffusion networks.

With several colleagues, I personally interviewed the forty-four residents of Solera in 1979 and 1980, and have closely observed the progress of solar diffusion in this social system. We obtained network data from our two sociometric surveys and by observation. Figures 8-6 and 8-7 show that the spatial location of these households was a very major determinant of the communication structure of this system; when the forty-four household were asked how frequently they talked with each of the other members of the system (not just about solar heating), three main cliques could be identified.* The Berenda Way clique consists of the eighteen families living

* Research evidence supporting this generalization is reviewed in Rogers and Kincaid (1981, pp. 197-324).

*This case illustration is based on Rogers (198Id).

* These cliques are visually apparent in the who-to-whom matrix of the network data (Figure 8-7), and were also identified by use of the NEGOPY computer program (described in Rogers and Kincaid, 1981).

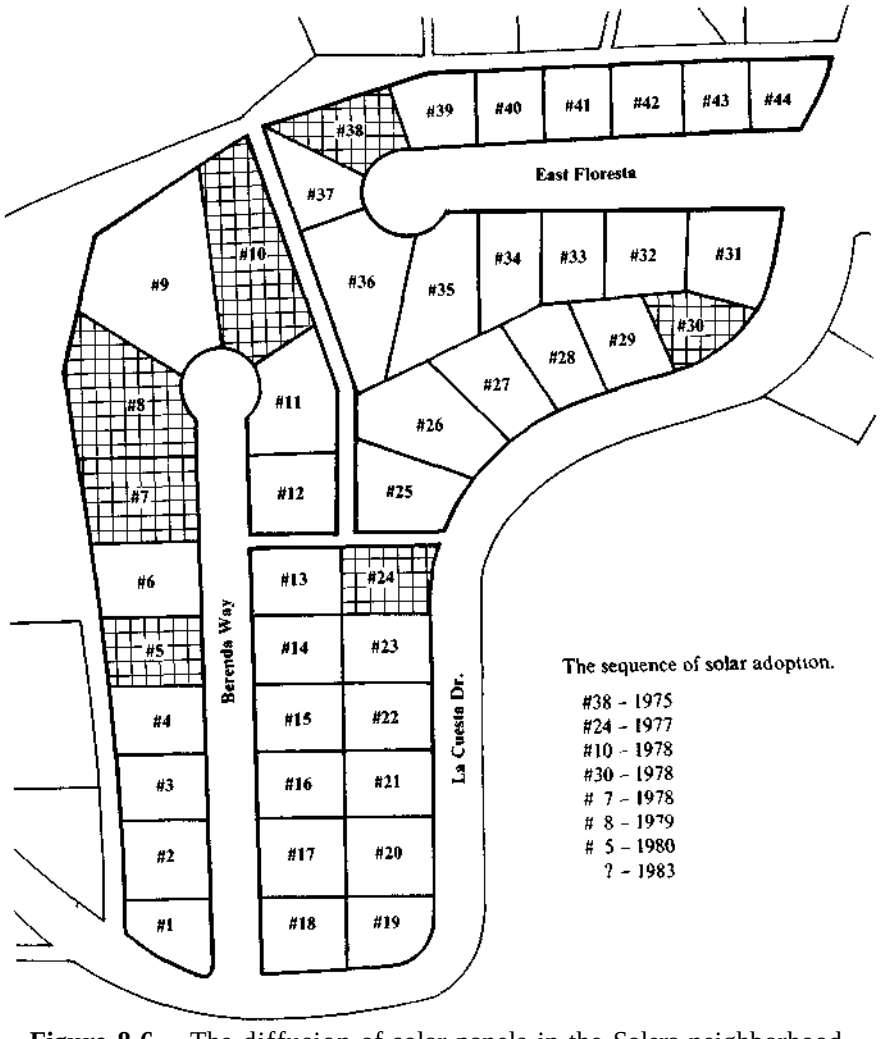

Figure 8-6. The diffusion of solar panels in the Solera neighborhood.

on the cul-de-sac by that name. The East Florestra clique includes fifteen households along another cul-de-sac, and the third clique is composed of eleven families on one side of La Cuesta Drive. Housewives #10, #24, and #40 are the most important opinion leaders in the system; they also provide interconnectedness to the total network through their "weak ties" to households who are not members of their own clique.

To what extent does this network structure, shown in Figure 8-7, predict the diffusion of solar panels, shown in Figure 8-6? Respondent #38 was the first solar adopter, constructing his own solar pool-heating equipment in 1975. Mr. 38 is an electrical engineer who works in an R&D laboratory. This

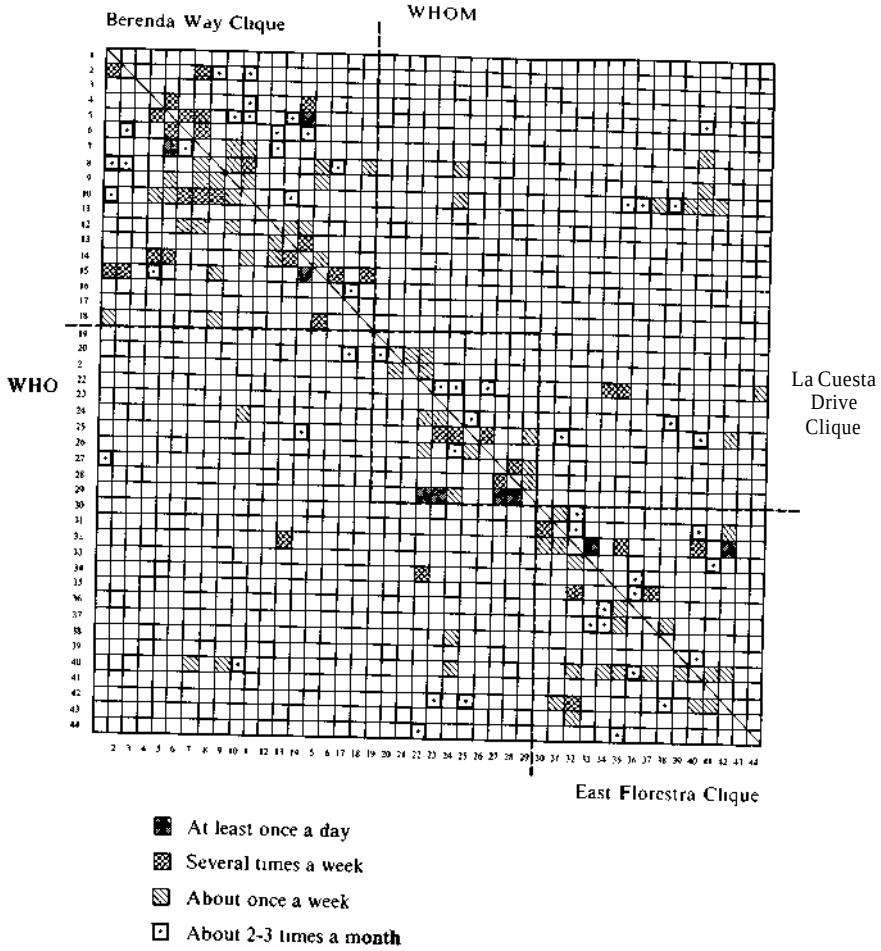

Figure 8-7. The who-talks-to-**whom matrix of** communication networks for the Solera Neighborhood.

Notice that spatial location is almost a complete explanation of clique membership of these forty-four households; the one exception is household 30, a semiisolate member of the East Florestra clique, even though this house faces on La Cuesta Drive.

first adopter is located at the end of a cul-de-sac, and is not socially well-connected with the neighborhood (as is characteristic of innovators).

The second residential adoption occurred two years later in 1977, when family #24 purchased solar collectors for domestic hot water heating. Mr. 24 has an M.B.A. and is a computer specialist. He likes to work with his hands, and installed his solar panels himself. Although aware of #38's prior adoption of solar, Mr. 24 considered his application of solar for domestic hot

water heating to be distinctive from #38's pool heating. Mr. 24's decision to adopt was triggered by the need to reroof his house. His wife is well known and respected in the neighborhood, and she became an opinion leader for the innovation among her friends, including Mrs. 10.

Three solar adoptions occurred during 1978. Number 10 installed a hot tub (for health reasons), and this triggered a decision to adopt solar (which -Mr. 10 had been considering for over a year, along with his close friend, Mr. 24). Number 10 is a psychologist and solar heating fit his strong desire to conserve energy. Mrs. 10 is the most influential opinion leader in the neighborhood, and she showed her solar equipment to several of her friends.

Among these is Mrs. 7, who adopted in 1978; her decision was triggered by the construction of a new room and bathroom (with a Jacuzzi). Mrs. 7 is also somewhat of an opinion leader on her street.

In contrast is #30, who adopted solar collectors for pool heating in 1978. The 30s are older and not well integrated into the neighborhood; at the time of our 1980 interviews with these homeowners, almost no one even knew that #30 had adopted. The solar panels are mounted on an inward-sloping roof, and cannot be easily seen from the street.

During 1979, #8 adopted solar panels for domestic hot water heating and for space heating a bedroom. A cluster of solar adopters is now building up on the Berenda Way cul-de-sac, and it became denser in 1980 when #5 adopted. An elderly lady, Mrs. 5, had a serious fire" in her house, and while her home was being reconstructed, she stayed with her friends, Mrs. 7 and Mrs. 10, both of whom were solar adopters. Mrs. 5's house was rebuilt with a hot tub, which helped convince her to purchase solar panels.

By 1981, 16 percent of the forty-four households had adopted solar equipment. The rate of adoption is highest on Berenda Way, where five out of eighteen households (28 percent) have solar. These eighteen families form a tight-knit clique, as do the fifteen households (#30 through #44) on East Florestra.

Why has solar adoption progressed more rapidly in the Berenda Way clique than on East Florestra? In the latter clique, neither of the two adopters (#30 and#38) are opinion leaders, and the most important leader (#40) does not think that solar adoption is practical. But on Berenda Way, the first solar adopters are opinion leaders (especially #10), and thus the "take-off" in the s-curve of adoption occurred.

Who will adopt solar next? Number 6 looks like a good bet; this family is surrounded by solar adopters, and is very friendly with these neighbors. Number 9 might also appear to be a future adopter, but Mr. 9 works at a distant site and is not home much. Another likely adopter might be #33, but this home on East Florestra is heavily shaded by several of the family's favorite trees.

Solar adopters often are found in spatial clusters in California, with three, four, or more adopters located on the same block. Such clusters occur

because the nearby neighbors of an initial adopter are influenced to adopt by the innovator's example, conveyed to them by interpersonal network channels. Soon a critical mass of adopters may build up in a neighborhood, and then the other homeowners are convinced to adopt. This "tipping point" occurs when a diffusion threshold of 10 to 20 percent adoption is reached, as has occurred in the Berenda Way clique.

This case illustration of solar diffusion in the Solera neighborhood helps show how the network structure of a system explains the time-order of who adopts an innovation. In Solera, communication networks are heavily dependent on spatial location, even for an innovation that is generally highly observable. Notice, however, that networks are by no means the sole determinant of adoption. Also important in this case are such cues-to-action as installing a hot tub or Jacuzzi (which require large amounts of energy for water heating), the need to reroof, and the accidental fire that required rebuilding a house.

Social Learning Theory

A social-psychological theory with direct applicability to diffusion networks is social learning theory. Most psychological approaches to human learning look within the individual in order to understand how learning occurs. But the social learning approach looks outside of the individual at information exchanges with others in order to explain how behavior changes. The intellectual leader of the social learning viewpoint is Professor Albert Bandura (1977) of Stanford University.

The central idea of social learning theory is that an individual learns from another by means of observational modeling; that is, one observes what another person is doing, and then does something similar. But not exactly the same thing. That would be simple imitation or blind mimicry. But social modeling permits the observer to extract the essential elements from an observed behavior pattern in order to create a similar behavior. Modeling allows the learner to adopt the observed behavior (much like the re-invention of an innovation).

The basic perspective of social learning theory is that the individual can learn from observation of other people's activities, so the individual does not actually need to experience a verbal exchange of information in order for the individual's behavior to be influenced by the model. Thus, nonverbal communication is considered important in behavior change (as well as verbal communication). Because social-learning theory recognizes external factors to the individual as important in behavior change, it is essentially "social," viewing communication as causing change, along with the individual's psychological make-up. The individual can learn a new behavior by observing another individual in person or via the mass media (especially the visual media like television or film). Social modeling can occur in interpersonal networks or by a public display by someone with whom one is unacquainted.

Contrasting Social Learning and Diffusion

There is obviously much in common between social learning and diffusion: both theories seek to explain how individuals change their overt behavior as a result of communication with another individual. Interpersonal networks are thus thought to be fundamental to behavior change, although neither theory claims that identical mimicking must occur. Both theories stress information exchange as essential to behavior change, and view such network links as the main explanation of how individuals alter their behavior.

Surprisingly few scholars have commented on this basic similarity of diffusion and social learning. Professor Bandura, in a recent textbook on social learning theory, provides a brief discussion of diffusion (Bandura, 1977, pp. 50-55), and his forthcoming book on applications of social learning theory features a chapter on the diffusion of innovations. A set of sociologists at the University of Arizona (Hamblin et al, 1973,1979; Pitcher et al, 1978; Kunkel, 1977) have applied social learning theory to data sets about the diffusion of innovations, such as the rate of airplane hijackings (Chapter 5). Their viewpoint is that "diffusion models portray society as a huge learning system where individuals are continually behaving and making decisions through time but not independently of one another. . . . Everyone makes his own decisions, not just on the basis of his own individual experiences, but to a large extent on the basis of the observed or talked about experiences of others" (Hamblin et al, 1979).

So there is a basic similarity between social learning theory and the diffusion of innovations. But there are also important differences.

1. In comparison to social learning, diffusion research has been more aggregate in measuring the effects of modeling as a crude dichotomy of either adopting or rejecting an innovation. Social learning perspectives would encourage diffusion researchers to measure

more exactly *what* the individual learns through a network link with an adopter of an innovation. This detailed learning might include: what resources of time, money, effort, skills, and mastery of technical jargon are necessary for the individual to adopt an innovation? Will the innovation solve the focal individual's perceived problem/need? What is the innovation's relative advantage over previous practice? How satisfied is the adopter-peer with the innovation? Such issues as these would focus diffusion research on the informational content that is exchanged in diffusion networks. The pursuit of such detailed issues might improve our understanding of exactly what information about an innovation diffuses via interpersonal networks.

2. A diffusion perspective, if more fully brought into social learning research, might provide greater attention to time as a variable in behavior change, thus making the social learning work focus more centrally on behavior change as a *process.* Unfortunately, social science research does not deal very adequately with analyzing over-time data. But more explicit attention to the time variable might enrich social learning research. In the past, however, the microlevel focus of social learning research on dyadic exchanges has distracted the attention of psychologists from time as a main variable. The more aggregate focus of diffusion studies meant that they could not easily avoid attempting to include time in their analyses.

3. Both social learning and recent diffusion research recognize that the individual does not always exactly mimic the model (diffusion researchers call this "re-invention"). Instead, the individual learner-adopter may abstract or generalize the information learned from the model. So the resulting behavior change may be a modification of that being modeled.

4. Both social learning and diffusion researchers have recently emphasized the exchange/convergence aspects of behavior change. Conventional learning research and mass communication research looked at individualistic aspects of learning/effects. Social learning and diffusion theory emphasize interpersonal information exchange as the basis for behavior change, but they were originally influenced by linear, one-way thinking. Recently, both sets of scholars have begun to move more forcefully toward focus on the mutual exchange of information between two or more individuals as the basis for the convergence in cognitive and behavioral change. Social learning theory has led diffusion theory in this promising direction.

Thus, it seems that the dialogue between these two theoretic viewpoints, social-learning theory and diffusion, has begun in earnest.

Perhaps their essential differences are mainly artifacts of discipline and method. We shall see.

Horizons for Social Modeling

In order for social modeling to occur, a focal individual obviously must be aware of the behavior of another individual in his personal communication network who has adopted the innovation to be modeled. An important research question, then, concerns the degree to which a focal individual is aware of the innovation behavior of various other individuals who are at different degrees of proximity from the focal individual. For example, we would expect a focal individual to be informed about the innovation behavior of a person with whom he or she has a direct network link, and to whom he or she may talk frequently. But what about a person who is two or three or more steps removed from the focal individual?

Several researchers have tried to answer this important research question. Lee (1977) found that women in Korean villages seemed to be influenced by the innovation behavior of other women who were directly linked to them, and by those who were linked through one intermediary. But beyond these two-step links, not much social modeling seemed to occur.

Another investigation bearing on this issue of the size of personal communication networks through which innovation influence flows is that by Friedkin (1981). This network scholar traced the influences of one scientist on the work of another, in six university departments, and found a similar "horizon" to observability in social modeling networks. Observability was restricted to persons who are in direct contact with a focal individual, or who have at least one friend in common. Unless scientists were linked by a minimum of at least two-step flows, little social modeling seemed to occur.

Summary

Opinion leadership is the degree to which an individual is able to influence informally other individuals' attitudes or overt behavior in a desired way with relative frequency. Opinion leaders play an important role in activating diffusion networks. The concept of opinion

Table 8-2. A Summary of Research Evidence Supporting and Not Supporting Generalizations about Opinion Leadership and Diffusion Networks.

Generalization		Support for the Generalization (Number of Research Studies)		Percentage of Research Studies Supporting the Generalization
		Supporting	*Not Supporting*	
8-1:	Interpersonal diffusion networks are mostly homophilous.	22	13	62
8-2:	When interpersonal diffusion networks are heterophilous, followers seek opinion leaders of higher socioeconomic status.	14	0	100
8-3:	When interpersonal diffusion networks are heterophilous, followers seek opinion leaders with more education.	6	2	75
8-4:	When interpersonal diffusion networks are heterophilous, followers seek opinion leaders with greater mass media exposure.	5	0	100
8-5:	When interpersonal diffusion networks are heterophilous, followers seek opinion leaders who are more cosmopolite.	1	0	100
8-6:	When interpersonal diffusion networks are heterophilous, followers seek opinion leaders with greater change agent contact.	2	0	100
8-7:	When interpersonal diffusion networks are heterophilous, followers seek opinion leaders who are more innovative.	10	1	91
8-8:	Opinion leaders have greater exposure to mass media than their followers.	9	1	90
8-9:	Opinion leaders are more cosmopolite than their followers.	10	3	77
8-10:	Opinion leaders have greater change agent contact than their followers.	10	3	77
8-11:	Opinion leaders have greater social participation than their followers.	11	4	73
8-12:	Opinion leaders have higher socioeconomic status than their followers.	20	7	74
8-13:	Opinion leaders are more innovative than their followers.	24	4	86
8-14:	When a social system's norms favor change, opinion leaders are more innovative, but when the norms do not favor change, opinion leaders are not especially innovative.	7	2	78
8-15:	The interconnectedness of an individual in a social system is positively related to the individual's innovativeness.	4	0	100
8-16:	The information-exchange potential of communication network links is negatively related to their degree of (1) communication proximity, and (2) homophily.	2	0	100
8-17:	Individuals tend to be linked to others who are close to them in physical distance and who are relatively homophilous in social characteristics.	9	0	100

leadership originated as part of the two-step flow model, which hypothesized that communication messages flow from a source, via mass media channels, to opinion leaders, who in turn pass them on to followers. The two-step flow model challenged the previous *hypodermic needle* model, which postulated that the mass media had direct, immediate, and powerful effects on a mass audience, which was viewed as a body of disconnected individuals connected to the mass media but not to each other. Research has since expanded our understanding of the variable number of steps in a multistep flow.

Homophily is the degree to which pairs of individuals who interact are similar in certain attributes, like beliefs, education, and social status. *Heterophily* is the degree to which pairs of individuals who interact are different in certain attributes. Interpersonal diffusion networks are mostly homophilous (Generalization 8-1). Such homophily can act as an invisible barrier to the rapid flow of innovations within a social system, as similar people interact in socially horizontal patterns.

When interpersonal diffusion networks are heterophilous, followers seek opinion leaders of higher socioeconomic status, with more education, greater mass media exposure, more cosmopoliteness, greater change agent contact, and more innovativeness (Generalizations 8-2 through 8-7). The evidence supporting these generalizations is summarized in Table 8-2.

Compared to followers, opinion leaders have greater mass media exposure, more cosmopoliteness, greater change agent contact, greater social participation, higher social status, and more innovativeness (Generalizations 8-8 through 8-13). Opinion leaders conform more closely to a system's norms than do their followers. When a social system's norms favor change, opinion leaders are more innovative, but when the norms do not favor change, opinion leaders are not especially innovative (Generalization 8-14).

Polymorphism is the degree to which an individual acts as an opinion leader for a variety of topics, while *monomorphism* is the tendency to act as an opinion leader for only a single topic. When the norms of a system are more modern, opinion leadership is more monomorphic.

A *communication network* consists of interconnected individuals who are linked by patterned flows of information. An individual's network links are important determinants of his or her adoption of innovations. The interconnectedness of an individual in a social system is positively related to the individual's innovativeness (Generalization 8-15). *Interconnectedness* is the degree to which the units in a social system are linked by interpersonal networks.

Networks provide a certain degree of structure and stability in the predictability of human behavior. *Communication structure* is the differentiated elements that can be recognized in the patterned communication flows in a system. This structure consists of the cliques within a system and the communication interconnections among them through bridges and liaisons. The basic criterion for assigning individuals to cliques is *communication proximity,* defined as the degree to which two linked individuals in a network have personal communication networks that overlap. A *personal network* consists of those interconnected individuals who are linked by patterned communication flows to a given individual.

Personal networks that are *radial* (rather than interlocking) are more open to an individual's environment, and hence play a more important role in the diffusion of innovations. The information-exchange potential of communication network links is negatively related to their degree of (1) communication proximity, and (2) homophily. This generalization (8-16) is a restatement of Granovetter's theory of "the-strength-of-weak-ties." Individuals tend to be linked to others who are close to them in physical distance and who are relatively homophilous in social characteristics (Generalization 8-17).

Social learning theory states that individuals learn from others that they observe, whom they then imitate by following a similar (but not necessarily identical) behavior. Such social modeling frequently occurs in diffusion networks.

CHAPTER 9

The Change Agent

For it is a/ways easier to help those who can help themselves than to help the helpless.

E. F. Schumacher (1973),
Small Is Beautiful:
Economics as if People Mattered.

One of the greatest pains to human nature is the pain of a new idea. It . . . makes you think that after all, your favorite notions may be wrong, your firmest beliefs ill-founded. .. . Naturally, therefore, common men hate a new idea, and are disposed more or less to ill-treat the original man who brings it.

Walter Bagehot (1873, p. 169),
Physics and Politics.

THIS CHAPTER is about the role of the change agent, his or her communication relationships with clients, and various diffusion strategies that may be employed to change clients' behavior. A *change agent* is an individual who influences clients' innovation decisions in a direction deemed desirable by a change agency. In most cases a change agent seeks to secure the adoption of new ideas, but he or she may also attempt to slow the diffusion process and prevent the adoption of certain innovations.

So much of this chapter would seem to be about one-way communication that is intended to change the innovation behavior of a client. But even in these infleunce attempts by change agents, the communication relationship between the agent and the client is important and the reality of the situation is that a good deal of two-way information exchange takes place. Especially in decentralized diffusion systems, the potential adopters may control their change agents; in some cases, certain of the "clients" serve as their own change agents.

Even in relatively centralized diffusion systems, the long-range goal of many change agents is to create conditions in which clients can help themselves, and thus work the change agent out of a job. So our definition of *communication* as a process in which the participants create and share information with one another in order to reach a mutual understanding, is appropriate to describe the contact between a change agent and his or her clients.

Until the 1970s it was assumed that professional change agents were a necessary ingredient in an effective diffusion program. Now we see that they are not always essential; in some diffusion activities, aides (less than fully professional change agents) fill the change agent role. The special advantages of aides in bridging the heterophily gap between professional change agents and clients was first realized in family-planning programs in Asia, and in poverty-oriented programs in the United States. Another alternative to employing professional change agents is provided by decentralized diffusion systems, which we shall also discuss in this chapter.

Change Agents as Linkers

A wide variety of occupations fit our definition of change agent: teachers, consultants, public health workers, agricultural extension agents, development workers, salespeople, and many others. All of these change agents provide a communication link between a resource system of some kind (commonly called a change agency) and a client system (Figure 9-1). One of the main roles of a change agent is to facilitate the flow of innovations from a change agency to an audience of clients. But for this type of communication to be effective, the innovations must be selected to match the clients' needs and problems. And for the linkage to be very effective, feedback from the client system must flow through the change agent to the change agency so that it can make appropriate adjustments on the basis of previous successes and failures.

Change agents would not be needed in the diffusion of innovations were there no social and technical chasm between the change agency and the client system. The change agency system is usually composed of individuals who possess a high degree of expertise regarding the innovations that are being diffused; change agency personnel may be Ph.D.s in agriculture, medicine, or other technical fields. Their

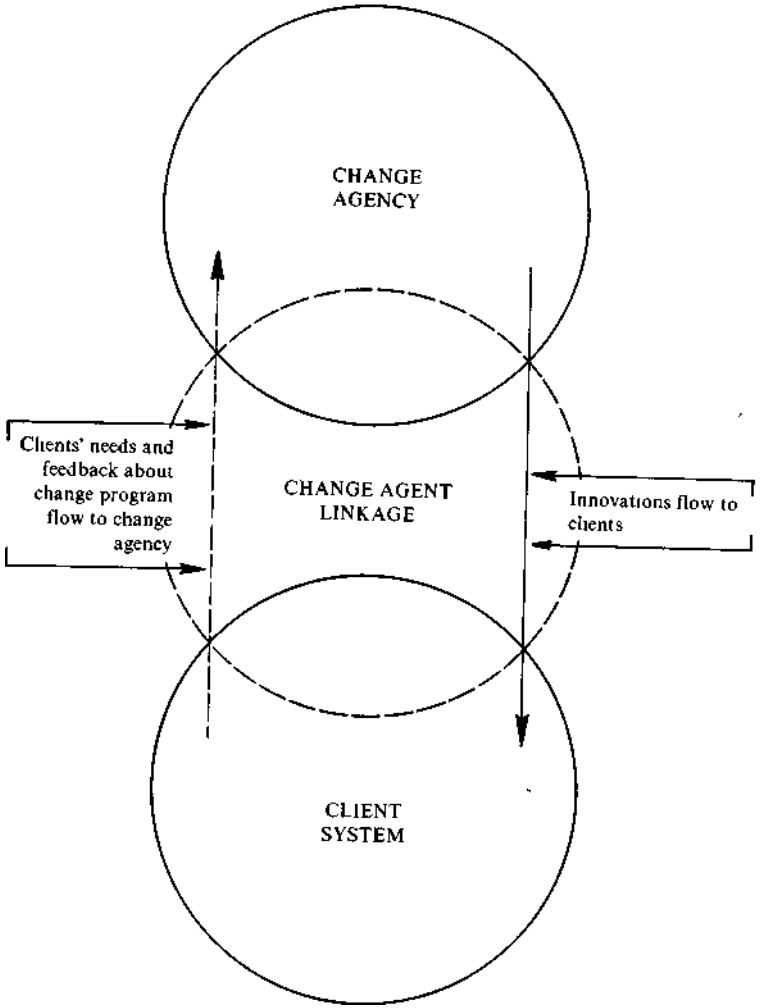

Figure 9-1. Change agents provide linkage between a change agency and ; client system.

The conventional role of the change agent is to diffuse innovations to clients, in what might seem to be a one-way persuasion process. But for this change process to be effective, the change agent must also provide linkage for clients' needs and problems to flow to the change agency, so they can be considered in determining which innovations are most appropriate to diffuse to clients. The change agent's role also includes obtaining feedback from clients about the change program. The change agent's position as a linker between the change agency and the client system leads to two problems: social marginality and information overload.

superior know-how makes it difficult for them to communicate directly with the client system. Accompanying their heterophily in technical competence is heterophily in subcultural language differences (even though both the change agent and the client may ostensibly share a common tongue), socioeconomic status, and beliefs and attitudes. Change agents, even though they link the two social systems, may also be quite heterophilous in relation to their clients and to their superiors in the change agency. This heterophily gap on both sides of the change agent creates role conflicts and problems in communication. As a bridge between two differing systems, the change agent is necessarily a marginal figure with one foot in each of two worlds. His or her success in linking the change agency with his or her client system often lies at the heart of the diffusion process.

In addition to facing this problem of social marginality, change agents also must deal with the problems of *information overload,* defined as the state of an individual or a system in which excessive communication inputs cannot be processed and utilized, leading to breakdown. The large volume of information about innovations flowing from the change agency often threatens to overcome the change agent's capacity to screen and select the most relevant messages for the client system. By understanding the needs and problems of his or her clients, a change agent can selectively transmit to them only information that is relevant.

The Sequence of Change-Agent Roles

If one follows the process of introducing a single innovation in a client system, seven roles can be identified for the change agent.

1. *Develops need for change.* A change agent is often initially required to help his or her clients become aware of the need to alter their behavior. In order to initiate the change process, the change agent points out new alternatives to existing problems, dramatizes the importance of these problems, and may convince clients that they are capable of confronting these problems. The change agent assesses clients' needs at this stage, and also may help to create these needs in a consultative manner.

2. *Establishes an information-exchange relationship.* Once a need for change is created, a change agent must develop rapport with his or her clients. The change agent can enhance his or her relationship with

clients by creating credibility in his or her competence, trustworthiness, and empathy with the clients' needs and problems. Clients must accept the change agent before they will accept the innovations that he or she promotes, because the innovations are often judged in part on the basis of how the change agent is perceived.

3. *Diagnoses their problems.* The change agent is responsible for analyzing his or her clients' problem situation in order to determine why existing alternatives do not meet their needs.* In arriving at such diagnostic conclusions, the change agent must view the situation empathically from the clients' perspective, not his or her own. The change agent must psychologically zip him or herself into the clients' skins, and see their situation through their eyes.

4. *Creates intent to change in the client.* After a change agent explores various avenues of action that his or her clients might take to achieve their goals, the change agent seeks to motivate an interest in the innovation. But the change must be client-centered, rather than innovation-oriented, focusing on the clients' problems.

5. *Translates intent into action.* A change agent seeks to influence his or her clients' behavior in accordance with recommendations based on the clients' needs. As we know from previous chapters of this book, interpersonal network influences from near-peers are most important at the persuasion and decision stage in the innovation-decision process. So the change agent can operate only indirectly here, by working with opinion leaders to activate peer networks.

6. *Stabilizes adoption and prevents discontinuances.* Change agents may effectively stabilize new behavior by directing reinforcing messages to those clients who have adopted, thus "freezing" the new behavior. This assistance is frequently given when the client is at the implementation or confirmation stage in the innovation-decision process.

7. *Achieves a terminal relationship.* The end goal for a change agent is to develop self-renewing behavior on the part of the client system. The change" agent should seek to put him or herself out of business by developing the clients' ability to be their own change agents. In other words, the change agent must seek to shift the clients from a position of reliance on the change agent to self-reliance.

*Many of the change agent's ethical problems center on this role of diagnosing clients' problems. The ethical question is often raised as to what right a change agent has to change the behavior of another individual. One situation might be in a case of informed consent (that is, when the client agrees to be changed in ways that the client understands in advance). Another might occur when the change agent, by reason of his or her special knowledge of innovations, can sense possible needs or problems of the clients that they do not yet see themselves.

Factors in Change Agent Success

Why are some change agents relatively more successful in introducing innovations? The answer seems to lie in a number of reasons, that are summarized in the remainder of this chapter.

Change Agent Effort

One of the factors in change agent success is the extent of effort he or she expends in communication activities with clients. Numerous evidence suggests Generalization 9-1: *Change agent success is positively related to the extent of change agent effort in contacting clients.* The degree of success of change agents is usually measured (in the studies synthesized in this chapter) in terms of the rate of adoption of innovations by members of the client system. This measure is similar to the rate of adoption dimension used as the dependent variable in Chapter 6. This success measure is frequently used because the main objective of most change agencies is to secure adoption of new ideas by their clients. As will be discussed in Chapter 11, an improved measure of change agent success is the degree to which desired consequences of innovation adoption occur among the clients, consequences such as improved levels of living, higher incomes, and the like.

Some of the strongest support for this proposition comes from a three-nation comparative investigation of the relative success of diffusion programs in 69 Brazilian communities, 71 Nigerian villages, and 108 Indian villages. Similar concepts and equivalent research procedures were used in each country, so that a general picture of variables related to change agent success could be obtained. The most important predictor of the success of village programs of agricultural change was the extent of change agent effort (Whiting et al, 1968; Hursh et al, 1969; Fliegel et al, 1967; and Rogers et al, 1970). "Success" villages, as contrasted with "failure" villages, were characterized by change agents who contacted more clients, spent fewer days in

their offices and more in the villages, and generally played an active rather than a passive role in the diffusion process. Increased interpersonal communication with clients, then, is crucial to change agent success.

Another large-scale investigation dealing with change agent success and using yet another research approach arrived at similar conclusions: change agent effort leads to success in introducing innovations to clients. Niehoff (1964, 1966a) concluded from his analysis of several hundred case studies, each dealing with a change agent's attempt to transfer an innovation cross-culturally, that one of the most fundamental factors in success is the extent of change contact with clients. This communication interface lies at the heart of the diffusion process.

The sheer amount of client contact is by no means the sole explanation of change agent success, however. For instance, the timing of the client contact, relative to the stage of diffusion of an innovation, is a factor in success. Stone (1952) analyzed the amount of effort expended by agricultural extension agents in promoting a new idea to Michigan farmers. In the first years of the diffusion campaign the rate of adoption of the innovation roughly paralleled the amount of change agents' efforts, as measured by the number of agent days a year devoted to the innovation. After about 30 percent adoption was reached, however, the extension agents' efforts decreased, whereas the farmers continued to adopt the new idea at an almost constant rate. Once the opinion leaders adopt, the adoption curve shoots upward in a self-generating fashion, and a change agent can begin to retire from the scene. The adoption curve will then continue to climb, independent of change agents' efforts, under further impetus from the opinion leaders.

Change Agency Versus Client Orientation

Because a change agent's position is located midway between the bureaucracy to which he or she is responsible and the client system in which he or she works, the agent is necessarily subject to role conflicts. The change agent is often expected to engage in certain behaviors by the change system, and at the same time he is expected by his client system to carry on quite different actions.

Typically, one finds a shift in orientation of the individuals

employed in a change agency, as one moves down from the top of the organizational hierarchy to the field level. At the top, change agency officials are loyal to national political leaders and to the country's goals. But in the field, local-level change agents empathize with their clients, and give priority to clients' problems. In fact, change agents are often personally liked by their clients to the extent that they seek to circumvent bureaucratic rules. This situation usually causes problems of marginalism for the local change agent, who becomes a man-in-the-middle between the superiors in the hierarchy and his or her clients.

There is often a basic incompatibility between national goals for a diffusion program versus the individual goals of the majority of clients. For example, consider an African nation in which about 40 percent of the staple food, corn, is produced by a few hundred commercial farmers who operate large-sized, highly mechanized farms (Roling, 1981). About 600,000 traditional farmers are responsible for the other 60 percent of corn production; they generally do not adopt chemical fertilizers, hybrid corn varieties, or new machines. This nation is currently importing large quantities of corn, and the national government has given a high priority to increasing its domestic production of corn. There are only a small number of agricultural extension workers.

Naturally, they are assigned to assist mainly the several hundred commercial farmers. But the result will be to widen the socioeconomic gap between these elite farmers versus the subsistance farmers (Chapter 11).

Generalization 9-2 states: *Change agent success is positively related to a client orientation, rather than to a change agency orientation.* Client-oriented change agents are more likely to be feedback-minded, to have close rapport and high credibility in the eyes of their clients, and to base their diffusion activities on clients' needs.

Compatibility with Clients' Needs

One of the most important and difficult roles for the change agent is diagnosing clients' needs. Diffusion campaigns often fail because change agents are more innovation-minded than they are client-oriented. They "scratch where their clients do not itch." We suggest Generalization 9-3: *Change agent success is positively related to the*

*degree to which the diffusion program is compatible with clients' needs.**

Change projects not based on clients' felt needs often go awry or produce unexpected consequences. For example, one Indian village was provided with development funds to construct irrigation wells that could approximately double their crop yields. But the villagers wanted wells for drinking because they had to carry their water about two miles from a river. The peasants built the wells in the village center, rather than in their fields, and drank the water, instead of irrigating their crops. If the change agent had based his program upon the felt needs of the villagers, he might have agreed to provide at least one well for drinking purposes, or else he could have tried to develop a felt need for irrigation by pointing out the financial advantages of this innovation.

Many change programs fail because they seek to swim against the tide of clients' cultural values without steering toward clients' perceived needs. Change agents must have knowledge of their clients' needs, attitudes, and beliefs, their social norms and leadership structure, if programs of change are to be tailored to fit the clients.

It is possible to allow clients to pursue the solution to their needs so completely that they commit errors or misdirect priorities. Niehoff (1964b) recounts a case of an unsupervised self-help program in Southeast Asia that led to unexpected results. Leaders in each village were allowed to decide on their own development projects; then a change agency provided construction materials, such as cement, hardware, and roofing materials. Hundreds of village projects were carried out, including building schools, roads, markets, irrigation canals, and dams. But it soon became apparent that half of the construction projects were Buddhist temples, a result hardly expected or desired by the government "change agency.

In this case national priorities did not match with villagers' needs. Similarly, the Kenyan government in the 1970s emphasized the diffusion of agricultural innovations to increase food production. But most village-level self-help projects consisted of building a primary school or a health clinic. The government could then often be convinced to contribute a teacher or a nurse to staff the new facility. The net result was to distort the government development plan, so that agriculture was shortchanged.

*This generalization has an obvious similarity to Generalization 6-2: *The compatibility of a new idea, as perceived by members of a social system, is positively related to its rate of adoption.*

Change agents must be aware of their clients' felt needs and adapt their diffusion programs to them. They should not, however, relinquish their role in developing and shaping these needs, so as to benefit the clients' welfare in the long run.

If change agent-client heterophily were not present, clients' needs would be identical with those of the change agents. To assess clients' needs, a change agent must be able to empathize with the client system, to see their problems through their eyes.

Change Agent Empathy

Change agent empathy with clients is especially difficult when the clients are very different from the change agents; we expect change agents to be more successful if they can empathize with their clients. Although there is very little empirical support for this expectation, we tentatively suggest Generalization 9-4: *Change agent success is positively related to empathy with clients.*

If empathy is important in change agent effectiveness, how can it be increased? One method lies in the selection of change agents; those who have once been in the client's role are probably better able to empathize with it. For example, agricultural change agencies often seek to employ change agents who come from farm backgrounds.

Homophily and Change Agent Contact

As previously defined, homophily is the degree to which pairs of individuals who interact are similar in certain attributes, and heterophily is the degree to which they differ. Change agents usually differ from their clients in most respects and tend to have most contact with those clients who are most like themselves. This general statement leads to a series of generalizations for which there is rather strong empirical support.*

* In addition, three generalizations about change agent contact were encountered in previous chapters: Generalization 5-5: *Earlier knowers of an innovation have greater change agent contact than later knowers;* Generalization 7-25: *Earlier adopters of innovations have more change agent contact than later adopters;* and Generalization 8-12: *Opinion leaders have greater change agent contact than their followers.*

Generalization 9-5: *Change agent contact is positively related to higher social status among clients.*

Generalization 9-6: *Change agent contact is positively related to greater social participation among clients.*

Generalization 9-7: *Change agent contact is positively related to higher education among clients.*

Generalization 9-8: *Change agent contact is positively related to cosmopoliteness among clients.*

The logic behind all of these generalizations is that more effective communication contact between change agents and their clients occurs when they are homophilous. Such effective communication is rewarding, and encourages change agents to contact clients who are much like themselves.

In a previous chapter, we presented the number of change agent contacts in the previous year for a sample of 1,307 Brazilian farmers (Figure 7-3):

	Number of Change Agent Contacts
Innovators	20
Early adopters	15
Early majority	12
Late majority	5
Laggards	3

These data are typical of a number of other studies. Change agent contact is one of the variables most highly related to innovativeness. Rogers et al (1970, pp. 6-12) concluded, on the basis of investigating fifteen variables related to innovativeness among almost 4,000 farmers in three developing nations: "The single variable that emerges as most highly related to change agent contact, even when the effect of other variables is controlled, is agricultural innovativeness." And in turn, socioeconomic status was highly related to innovativeness. Thus, in a diagrammatic form, these variables appear as:

Socioeconomic Status → Change Agent Contact → Innovativeness

This cozy circle of relationships is troublesome to change agents who worry that they are least helping those clients who most need their help. During the 1970s, as most change agencies became particularly concerned with the issue of equity, various alternatives to the usual status-contact-innovativeness relationship was sought.

Change Agent Contact with Lower-Status Clients

There can be little doubt that less-educated, lower-income clients need the assistance of change agents more than do more elite clients. Then why don't change agents concentrate their efforts on their most disadvantaged clients?

One reason is because of the homophily principle, already mentioned. More elite clients are homophilous with the change agent, and so communication between the two is easier and more effective. Lower-status clients are socioeconomically different from the change agent, and this heterophily gap impedes effective communication. If the change agent is an employee of a government agency or some other establishment institution, the lower-status client may distrust the change agent.

Further, the less-privileged clients often lack the necessary resources to adopt the innovations that the change agent is promoting. In fact, the innovations being diffused by a change agent may only fit the conditions of the more elite clients. In this case, one can hardly blame the disadvantaged clients for not adopting, but change agents tend to avoid further contact with them because they cannot see much benefit from their previous contact.

Finally, many change agents do not really try to contact their needy, lower-status clients because of a self-fulfilling prophecy that the change agents have developed from their past experience and, perhaps, from their training in diffusion theory (Roling, 1981; Roling et al, 1976). The change agents think that their lower-status clients are not responsive to the change agents' efforts at diffusion; this stereotype in the change agents' minds then serves to discourage them from initiating contact with these less-advantaged clients. They rationalize this lack of contact by their interpretation of diffusion theory, which they use to justify their concentrated contact with elite clients (innovators and early adopters) from whom they expect innovations to trickle down to the less-advantaged clients. Thus, diffusion theory, as they understand it, is used as an excuse for noncontact with less-elite clients. It should not be.

What can be done to ensure that the lowest-status and least-innovative clients have more change agent contact? One answer is to select change agents who are as much like their clients as possible. If most clients possess only a few years of formal education, a university-trained change agent will likely face greater communication difficulties than if he or she had less education. Evidence supporting this

statement comes from a study by the Allahabad Agricultural Institute (1957) in India. Village-level change agents with only an elementary education were more effective in reaching illiterate Indian villagers than were change agents with high school or university education. Similar findings are reported by other scholars, which leads to Generalization 9-9: *Change agent success is positively related to homophily with clients.*

Increasing the technical training of a change agent does not necessarily lead to his or her improved performance, measured as the clients' adoption of innovations. In fact, lower performance often results, contrary to conventional wisdom, because the increased professionalism of the change agent creates a wider heterophily gap with the clients.

The problems of change agent-client heterophily are described by Placek (1975) in his analysis of the ineffective diffusion of family planning ideas from welfare workers to their clients in a city in Tennessee. Federal regulations require that welfare mothers be informed about contraceptives by their welfare workers. And although the welfare professionals tried to act as change agents for diffusing family planning to welfare mothers, almost no adoption resulted. Why? It was not because the welfare mothers wanted to have more children; Placek found that 51 percent of the 1,141 pregnancies occurring to his 300 respondents were unwanted at the time of conception.

Placek (1975) concludes that the main reason for a lack of family planning diffusion was because of the extreme heterophily between the professional change agents and their clients. The welfare workers were mainly white, middle-class, college graduates. The welfare mothers were 80 percent black and most had not completed high school. Both the social workers and the welfare mothers were females, but the professionals were married without children, while the mothers were unmarried and had three or more children. Further, the clients did not trust the welfare workers because of their disciplinary role; the social workers sometimes conducted midnight raids in order to determine if illicit sexual relationships existed that would allow a welfare mother to be dropped from the welfare rolls, under man-in-the-house laws. This client distrust of their welfare worker destroyed safety credibility, as the welfare mothers did not feel that the professionals were looking out for the clients' benefit.

What could be done to close this heterophily gap between the social workers and the welfare mothers? Placek (1975) recommended employing certain of the welfare mothers as change agent aides to disseminate family-planning information.

Paraprofessional Aides

An *aide* is a less than fully professional change agent who intensively contacts clients to influence their innovation decisions. A wide variety of paraprofessional aides function as change agents, ranging from "barefoot doctors" in China, to paralawyers in U.S. poverty programs, to teachers' aides. One of the important advantages of aides is that there is much lower cost per client contacted; a rule of thumb in family planning programs in Asian nations is that thirty aides can be employed for the same cost as one medical doctor. Their lower cost is a compelling reason to employ aides, as they allow more reasonable change agent-client ratios. For instance, there are about 10,000 farmers for each agricultural extension agent in many developing nations (Rice, 1974, p. 121). How can an extension worker contact 10,000 clients? It's not possible.

Unfortunately, the budgets of most change agencies cannot be expanded to provide a more reasonable change agent-client ratio, if only professional change agents are employed. Anyway, not enough professionals exist in many fields in developing nations, and it would take years to train them with university degrees, even if funds to hire them were available. So there is not much alternative to employing aides, especially if client ratios of 1:400 or 1:500 are to be reached, as is recommended as an ideal level. With such an intensive number of change agents to clients, change agents can personally contact each of their low-status clients.

But the main advantage of paraprofessionals over professional field workers is that the aides are socially closer to the lower-status members of the user system that they serve. For instance, barefoot doctors in China spend about one-third of their time doing farm work, they are recruited from the same local village to which they will provide health care, and they are given only a minimum of preservice training (in part, so as to prevent them from "growing away" from their clients). As a result, most Chinese villagers and urban poor perceive their barefoot doctor as a peer, although a peer who has received some specialized health/family planning training.

Technical expertise may not be the most important quality of a change agent in the eyes of the user system. Personal acceptability of the worker may be as important, or even more important, than technical expertness. Obviously, paraprofessional aides are much less technically expert than are professional development workers, but they often more than make up for their lower degree of technical expertness through their greater social expertness. For example, family

planning aides in most nations of Asia and Latin America are female paraprofessionals, who are better able to discuss the sensitive topic of contraception with female clients than are predominately male doctors (Rogers, 1973).

Thus, selection according to such factors as sex, education, and personal acquaintance with the user system can help minimize the social distance between the change agent system and the client system, especially in diffusion programs intended to alleviate poverty and attain greater socioeconomic equality in a system. Aides can "halve" the social distance gap between professionals and low-status clients.

Barefoot Doctors in China*

The most famous change agent aides in the world are undoubtedly the barefoot doctors in the Peoples' Republic of China. There are 1.8 million barefoot doctors, one for every 400 people in rural areas. When U.S. visitors first began to return from China in the early 1970s, they described barefoot doctors as a kind of medical supermen who performed a variety of health tasks, including surgical operations, after only a few months of medical training. Perhaps the name "barefoot doctors" also helped focus world attention on these aides; "barefoot" *(chijiao)* in the expression *chijiao yisheng* (barefoot doctor) emphasizes that these individuals are first of all peasants who often work barefoot in the rice fields of South China. Actually, most barefoot doctors wear shoes. But their unusual name helps indicate that barefoot doctors are socially very close to the rural villagers they serve. Such homophily is an important reason for their effectiveness.

The need for barefoot doctors was recognized by Chairman Mao Zedong when he issued his June 26, 1965, directive criticizing the Chinese Ministry of Health for not giving greater attention to improving rural health. At that time, most of China's medical doctors were concentrated in the cities, and as a result villagers were virtually without modern medical care. Mao's order set off a series of local experiments with various types of health aides, which in 1965-1966 led to creation of the concept of barefoot doctors in a commune near Shanghai. An evaluation of this pilot project was favorable, and Mao endorsed the concept in a 1968 issue of *People's Daily,* China's widely read newspaper. By the mid-1970s, every village in China had its barefoot doctors.

The barefoot doctor concept was indeed a radical innovation: barefoot doctors are not a paramedical or doctor's auxiliary, working under close supervision. They are actually part-time doctors trained to diagnose and treat common diseases without professional assistance. It might be expected that such a radical idea would face stiff opposition from the medical profes-

* Based on Rogers (1980), and used by permission.

sion, but in China Mao had virtually wiped out the Ministry of Health in 1966 during the Cultural Revolution. So the medical profession was essentially bypassed in establishing the new rural health system.

We interviewed about fifty barefoot doctors during our visit to China in 1978 as members of a rural health delegation. We inspected the contents of the barefoot doctors' health kits, and generally tried to determine the scope of these aides' medical and health duties.

One of the important tasks of the barefoot doctor is to refer difficult cases to the commune hospital, where surgical equipment, a blood supply, and x-ray machines are available. We found that relatively few patients are referred; barefoot doctors can handle most of the patients' illnesses that arise. So barefoot doctors give vaccinations, suture lacerations, insert IUDs, perform abortions, and deliver babies. We encountered several barefoot doctors who set fractured bones and one who had performed an emergency appendectomy.

In addition to their health work, barefoot doctors typically spend part of their time raising herbs and doing farm work. An herb garden is usually adjacent to the barefoot doctor's health clinic in a village, and the herbal medicines that are raised help lower the costs of health care. Barefoot doctors also give acupuncture treatment, and provide a variety of other traditional Chinese medical cures. The farmwork performed by barefoot doctors seems to be symbolically and socially important in facilitating homophily between barefoot doctors and their farmer-clients. Manual work is generally praised at all levels in China as a social-leveling device. A further advantage of farm work by barefoot doctors is that it guarantees full-time employment for the barefoot doctor, even when health work may be slack. Change agent-client homophily is also facilitated by the selection procedures for barefoot doctors: they must have at least six years of formal schooling, come from poor or lower-middle-class parents, and have an altruistic commitment to serve the people. Candidates are chosen by their peers in the village. The new barefoot doctor then goes to the commune hospital for three to six months of preservice training in both Western and traditional Chinese medicine. Such short training prevents the barefoot doctor from growing away from his or her clients. After some years of experience, a barefoot doctor may return to the hospital for some further training, perhaps in a specialized field such as family planning.

With such brief training, how can barefoot doctors provide primary medical care? Most of their patients have colds, injuries, or other minor problems; serious medical problems are rare. And the barefoot doctors are not the paramedical superhumans that some previous accounts might lead one to expect. Barefoot doctors make some mistakes in diagnosis, in referral decisions, and in treatment. Given their limited training and lack of medical supervision, such occasional mistakes are inevitable. But China does not have a choice between high-quality versus low-quality medical services; the

present low-cost rural health system is certainly far superior to nothing at all, which was what was available to most rural people prior to 1965.

The barefoot doctor concept has been copied, often in a modified form, by a number of other developing nations since the mid-1970s. One of the most important lessons learned from the barefoot doctors in China is the great importance of change agent-client homophily in contributing to the safety credibility with which clients perceive the change agent.

Change Agent Credibility

Even though aides have less *competence credibility,* defined as the degree to which a communication source or channel is perceived as knowledgeable and expert, they have the advantage of *safety credibility,* the degree to which a communication source or channel is perceived as trustworthy. Because an aide is a peer to his or her clients, they are not likely to suspect the aide of having selfish motives or manipulative intentions. The aide is enough like the client to serve as a comparable role model. If the aide has already adopted an innovation that he or she is promoting, his or her personal experience with the new idea helps to reduce the clients' uncertainty in evaluating it.

Generally, heterophilous sources/channels (like professional change agents) are perceived as having competence credibility, and homophilous sources/channels (like aides) are perceived as having safety credibility. Perhaps the ideal change agent would represent a balance of competence and safety credibility. One combination is a change agent who is homophilous with his or her clients in social characteristics (such as socioeconomic status, ethnicity, and the like) but heterophilous in regard to technical competence about the innovations being diffused. Of course, such an ideal combination is very unlikely because technical competence usually derives from a university education, which in turn means that the change agent is socially different from most clients.

The aide that has adopted an innovation that he or she is promoting, however, approaches this ideal combination of homophily/heterophily. An interesting illustration is provided by vasectomy "canvassers" in India, who are paid a small fee for each adopter of male sterilization that they bring to a health clinic (Repetto, 1969). The canvassers were as poor, uneducated, and low in socioeconomic status as the client system, but these aides also possessed a kind of competence credibility in that they had all previously had vasectomies.

So the Indian canvassers had both safety credibility on the basis of their social homophily, and competence credibility owing to their technical heterophily from having already adopted the innovation.

Government employees, such as health educators, also promoted the adoption of vasectomy in India, but they were much less effective than the canvassers in convincing clients to adopt. The canvassers were supersalesmen for vasectomy, ranging over a one-hundred-mile radius in search of adopters, and working a six- or seven-day week. A crucial point in the adopter's decision process occurred when the canvasser showed his operation scar, as evidence that he knew what he was talking about. This act helped establish the aide's competence credibility with his clients.

An interesting test of the importance of clients' perceptions of change agents' credibility is provided by the two agricultural extension services of Taiwan. One extension service is operated by the national government's ministry of agriculture, and, as is the custom in most countries, employs university graduates in agriculture as its local extension agents. In the other system extension agents work for township farmers' associations; these extension workers have somewhat less technical training and are less professional. Both sets of extension workers seek to diffuse the same agricultural innovations to the same target audience of farmers.

But the government extension agents are much less successful than the extension workers employed by the local farmers' associations (Lionberger and Chang, 1970). Why? One important reason is that the township farmers' associations have a great deal of direct influence on their extension workers (who thus work for the farmers); as a result, almost all farmers are regularly contacted by the extension aides, and the farmers' needs and problems are given priority, rather than government goals. Further, the less-professional extension workers typically are part-time farmers themselves, and do not recommend an agricultural innovation to their neighbors/clients until they have already adopted it themselves. The more professional type of government extension workers are socially less homophilous with the farmers, and cannot give personal testimonials for the innovations that they promote; in fact, government regulations prohibit these extension agents from also operating a farm.

The evidence just reviewed suggests Generalization 9-10: *Change agent success is positively related to credibility in the clients' eyes.*

One type of change agent that suffers from generally low credibility is commercial salespeople. The adoption of a new idea almost al-

ways entails the sale of a new product. For some innovations and under some conditions, commercial change agents play an important role in the diffusion of innovations. But commercial change agents are often regarded with low credibility by their clients. For example, the author found that 97 percent of his Ohio farmer respondents said they would more likely be convinced of an innovation if they talked about it with a neighbor rather than with a salesman.

The commercial change agent's motives, as perceived by his or her clients, may be one reason for the low credibility they place in his or her recommendations. They feel that salespeople may seek to promote the overadoption of new ideas, perhaps in order to secure higher sales. Commercial change agents are most important as a source/channel at the trial-implementation stage in the innovation-decision process (Ryan and Gross, 1943; Beal and Rogers, 1957; and Copp et al, 1958): the client may purchase a small amount of the new product for trial. It is at this point that he relies heavily upon commercial change agents for information on how to use the innovation. Their credibility is limited to "how-to" information and does not usually extend to an ability to persuade the individual to form a favorable attitude toward the innovation. Such persuasive credibility is accorded to peers, non-commercial change agents, and other sources who have nothing to gain, at least not to the extent that the commercial agent has.

In some cases, commercial channels/sources can also be important in creating awareness-knowledge of an innovation. For instance, the Coleman et al (1966) drug study found that detailmen and commercial publications were reported by about 80 percent of the medical doctors as their source of knowledge about gammanym. Detailmen are employees of pharmaceutical firms who call on doctors to provide them with details about medical innovations, and to leave them free samples of new drugs. About 25,000 drug detailmen are presently employed in the United States to contact physicians, pharmacists, and hospital purchasing agents (Banta, 1981, p. 367). The value of such change agent contact to the drug companies is indicated by the fact that detailmen are paid about $150 for each medical doctor whom they contact. But the drug detailmen are not credible at the persuasion and decision stages in the innovation-decision process, when a doctor is deciding whether or not to adopt (Coleman et al, 1966). Commercial change agents are not perceived as credible for evaluative information about an innovation; uncertainty about the value of an innovation is best resolved through interpersonal communication with peers.

Inauthentic Professionalization of Aides

We have shown that aides have the advantage of lower cost per client contact and a greater ability to bridge the heterophily gap, when compared with professional change agents. These advantages do not mean, however, that the professionals are no longer needed in diffusion programs. They are still essential to train and supervise the aides, and to serve as a technical back-up for special problems that aides cannot handle. But the role of the professional is quite different as a supervisor of aides, from his role in directly contacting clients.

One of the particular problems often encountered with aides is *inauthentic professionalism,* the process through which an aide takes on the dress, speech, or other identifying marks of a professional in his or her field. For instance, the vasectomy canvassers in India demanded uniforms, identification badges, and other symbols of professional change agents (Repetto, 1969). Family planning aides in Indonesia insist on being supplied with bicycles and motor bikes, not only as a means of transportation to clients' homes, but also as a mark of professional status. Aides usually admire the professional change agents who supervise them, and so, quite naturally, they want to become more like them. They cannot gain the university degree that the professional possesses, and so they try to sound and look like them. But such inauthentic professionalization destroys the very heterophily-bridging function for which the aides were employed (Rogers, 1973, p. 130). Usually, if aides are made aware of the problem of inauthentic professionalism, they will act in ways to correct this threat to their effectiveness.

Opinion Leaders

Opinion leadership is the degree to which an individual is able to influence informally other individuals' attitudes or overt behavior in a desired way with relative frequency. Diffusion campaigns are more likely to be successful if change agents identify and mobilize opinion leaders. Generalization 9-11 is: *Change agent success is positively related to the extent that he or she works through opinion leaders.*

The time and energy of the change agent are scarce resources. By focusing communication activities upon opinion leaders in a social

system, the change agent can hasten the rate of diffusion. Economy of effort is achieved because contacting opinion leaders takes far less of the change agent's resources than if each member of the client system were to be consulted. Essentially, the leader approach magnifies the change agent's efforts. Furthermore, by enlisting the aid of opinion leaders, the change agent provides the aegis of local sponsorship and sanction for the new ideas. As we have shown elsewhere in this book, network messages from near-peers like opinion leaders are regarded as credible in convincing an individual to adopt an innovation. In fact, after the opinion leaders in a social system have adopted an innovation, it may be impossible to stop its further spread.

Change agents sometimes mistake innovators for opinion leaders. They may be the same individuals, especially in systems with very modern norms, but they often are not. Opinion leaders have followings, whereas innovators are simply the first to adopt new ideas. When the change agent concentrates communication efforts on innovators, rather than on opinion leaders, the results may help to increase awareness knowledge of the innovations, but few clients will be persuaded to adopt. The innovators' behavior does not necessarily convince the average client to follow suit. Another difficulty occurs when a change agent correctly identifies the opinion leaders in a system but then proceeds to concentrate his or her attention so much on these few leaders that they may become *too* innovative in the eyes of their followers, or become perceived as too friendly and overly identified with the change agent. Thus, a change agent can "wear out" the credibility of opinion leaders by making them too innovative. Such a problem has occurred in various diffusion programs; it is somewhat analogous to the problem of inauthentic professionalization of aides.

Clients' Evaluative Ability

One of the change agent's unique contributions to the diffusion process is technical competence, which allows him or her to provide this expertise to clients in making innovation decisions. But if the change agent takes a long-range approach to change, he or she should seek to raise the clients' technical competence and ability to evaluate potential innovations themselves. Then, eventually, the clients could become their own change agents. This suggests Generalization 9-12: *Change agent success is positively related to increasing clients' ability to evaluate innovations.* The limited empirical support for this statement comes largely from several descriptive case studies.

Unfortunately, change agents often are more concerned with such short-range goals as escalating the rate of adoption of innovations. Instead, self-reliance should be the goal of change agencies, leading to termination of client dependence upon the change agent. This goal, however, is seldom reached by most change agencies; they usually promote the adoption of innovations, rather than seeking to teach clients the basic skill of how to evaluate innovations themselves.

Centralized and Decentralized Diffusion Systems

FIRST GAMBLER (arriving in town): Any action around?
SECOND GAMBLER:Roulette.
FIRST GAMBLER: You play?
SECOND GAMBLER: Yes.
FIRST GAMBLER: Is the wheel straight?
SECOND GAMBLER: No.
FIRST GAMBLER: Why do you play?
SECOND GAMBLER: It's the only wheel in **town.**

The Classical Diffusion Model

For decades, one diffusion model dominated the thinking of scholars arid policy makers. In this classical diffusion model, an innovation originates from some expert source (often an R&D organization). This source then diffuses the innovation as a uniform package to potential adopters who accept or reject the innovation. The role of the adopter of the innovation is that of a passive accepter. This classical model owes much of its popularity to the success of the agricultural extension services and to the fact that the basic paradigm for diffusion research grew out of the Ryan and Gross (1943) hybrid corn study. Much agricultural diffusion in the United States is relatively centralized, in that key decisions about which innovations to diffuse, how to diffuse them, and to whom, are made by a small number of technically expert officials near the top of a diffusion system.

The classical diffusion model was recently challenged by Schon (1971), who noted that diffusion theories lagged behind the reality of emerging diffusion systems. He particularly criticized the classical dif-

fusion theory (which he called the "center-periphery model") because of its assumption that innovations should originate from a centralized legitimizing source and then diffuse to users. While recognizing that this classical model fits much of reality, Schon noted that it fails to capture the complexity of relatively decentralized diffusion systems in which innovations originate from numerous sources and evolve as they diffuse via horizontal networks.

During the late 1970s I gradually became aware of diffusion systems that did not operate at all like the relatively centralized diffusion systems that I had described in my previous books. Instead of coming out of formal R&D systems, innovations often bubbled up from the operational levels of a system, with the inventing done by certain users. Then the new ideas spread horizontally via peer networks, with a high degree of re-invention occurring as the innovations are modified by users to fit their particular conditions. Such decentralized diffusion systems usually are not run by a small set of technical experts. Instead, decision making in the diffusion system is widely shared with adopters making many decisions. In many cases, adopters served as their own change agents.

Gradually, I began to realize that the centralized diffusion model was not the only wheel in town.

Comparing Centralized Versus Decentralized Diffusion Systems

How does a decentralized diffusion system differ from its centralized counterpart? Table 9-1 presents six of the main differences between centralized and decentralized diffusion systems; our distinction is somewhat oversimplified because it suggests a dichotomy (rather than a continuum) of centralized/decentralized diffusion systems. In reality, an actual diffusion system is usually some combination of the elements of a centralized and a decentralized diffusion system. For example, the agricultural extension services in the United States are nearer the more centralized end of the decentralized/centralized continuum, although they have certain characteristics of a decentralized system (Figure 9-2). A number of other relatively centralized diffusion systems have been created in education, family planning, business, and other fields, based on extensions of the agricultural extension model (Rogers et al, 1982a).

In general, centralized diffusion systems are based on a linear,

Table 9-1. Characteristics of Centralized and Decentralized Diffusion Systems

Characteristics of Diffusion Systems	Centralized Diffusion Systems	Decentralized Diffusion Systems
1. The degree of centralization in decision making and power.	Overall control of decisions by national government administrators and technical subject-matter experts	Wide sharing of power and control among the members of the diffusion system; client control by local community officials/leaders.
2. Direction of diffusion.	Top-down diffusion from experts to local users of innovations.	Peer diffusion of innovations through horizontal networks.
3. Sources of innovations.	Innovations come from formal R&D conducted by technical experts.	Innovations come from local experimentation by nonexperts, who often are users.
4. Who decides which innovations to diffuse?	Decisions about which innovations should be diffused are made by top administrators and technical subject-matter experts.	Local units decide which innovations should diffuse on the basis of their informal evaluations of the innovations.
5. How important are clients' needs in driving the diffusion process?	An innovation-centered approach; technology-push, emphasizing needs created by the availability of the innovation.	A problem-centered approach; technology-pull, created by locally perceived needs and problems.
6. Amount of re-invention?	A low degree of local adaptation and re-invention of the innovations as they diffuse among adopters.	A high degree of local adaptation and re-invention of the innovations as they diffuse among adopters.

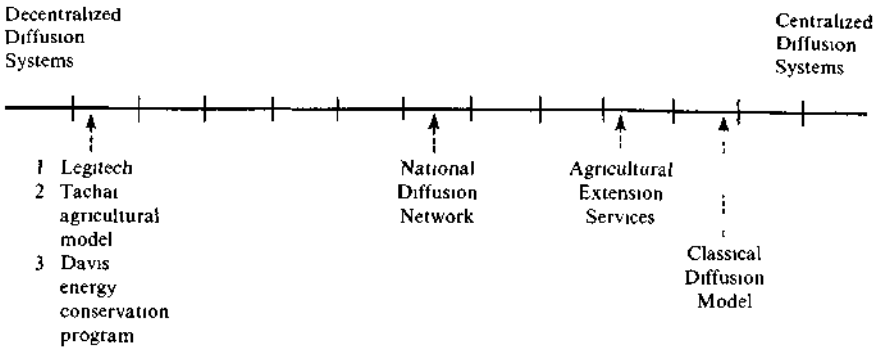

Figure 9-2. The continuum of decentralized and centralized diffusion systems.

The classical diffusion model is relatively centralized, and it was not until recent years that diffusion scholars began to realize that actual diffusion systems ranged on a continuum. Even though the agricultural extension service in the United States is relatively centralized, as are many diffusion systems modeled after it, several diffusion systems described in this chapter are relatively decentralized.

one-way model of communication. Decentralized diffusion systems more closely follow a convergence model of communication, in which participants create and share information with one another in order to reach a mutual understanding. A fundamental assumption of decentralized diffusion systems is that members of the user system have the ability to make sound decisions about how the diffusion process is managed. This capacity of the users to run their own diffusion system makes the most sense (l) when the users are highly educated and technically competent practitioners (for example, cardiovascular surgeons), so that all the users are experts, or (2) when the innovations being diffused are not at a high level of technology (for example, home energy conservation or organic gardening versus building a nuclear power plant), so that intelligent laymen have sufficient technical expertise.

The fact that relatively decentralized diffusion systems exist in a wide variety of fields and locations suggests that in the past we may have severely underestimated the degree to which the user system was capable of managing its own diffusion processes. Our understanding of decentralized diffusion systems is still limited, owing to the general lack of investigations of such user-dominated diffusion. But it seems apparent that certain elements of decentralized diffusion systems might be combined with certain aspects of the centralized model to fit

a particular situation uniquely. In other words, the classical diffusion model is being questioned in certain very important ways.

Advantages and Disadvantages of Decentralized Diffusion

Decentralized diffusion systems have both advantages and disadvantages. Compared to centralized systems, the innovations that decentralized systems diffuse are likely to fit with users' needs and problems more closely. Users feel a sense of control over a decentralized diffusion system, as they participate in making many of the key decisions, such as which of their perceived problems most need attention, which innovations best meet these needs, how to seek information about each innovation and from what source, and how much to modify an innovation as they adopt and implement it in their particular setting. The high degree of user control over these key decisions means that a decentralized diffusion system is geared closely to local needs. Problems of change agent-client heterophily do not exist, or are minimized. It is mainly user motivations to seek innovations that drive a decentralized diffusion process, and this may be more cost efficient than situations in which professional change agents manage the diffusion process. User self-reliance is encouraged in a decentralized system. Finally, decentralized diffusion is publicly popular; users generally like such systems.

Several disadvantages, however, usually characterize decentralized diffusion systems (in comparison with centralized diffusion systems):

1. Technical expertise is sometimes difficult to bring to bear on decisions about which innovations to diffuse and to adopt, and it is possible for "bad innovations" to diffuse through a decentralized system because of this lack of "quality control." So when a diffusion system is disseminating innovations that involve a high level of technical expertise, a decentralized diffusion system may be less appropriate than a more centralized diffusion system.

2. Furthermore, extremely decentralized diffusion systems lack a coordinating role (that is, the "big picture" of the system, where problems exist and which innovations might be used to solve them). For example, a local user may not know which other users he or she could go to site-visit an innovation. Completely decentralized diffusion systems thus may suffer from the fact that local users, who con-

trol the system, lack certain aspects of the big picture about users' problems and about available innovations.

3. Sometimes a national government wants an innovation diffused for which the people do not feel a need. In a highly decentralized system, such an innovation simply will not diffuse. An example is family planning in developing nations, which a government may regard as a high priority but which local people may not want. There are very few decentralized diffusion systems for contraception in Latin America, Africa, and Asia.

Our present discussion suggests that:

1. Decentralized diffusion systems are most appropriate for certain conditions, such as for diffusing innovations that do not involve a high level of technical expertise, among a set of users with relatively heterogeneous conditions. When these conditions are homogeneous, a relatively more centralized diffusion system may be most appropriate.

2. Certain elements of centralized and decentralized diffusion systems can be combined to form a diffusion system that uniquely fits a particular situation. For example, a diffusion system may combine a central-type coordinating role, with decentralized decisions being made about which innovations should be diffused and which users others should site-visit. Technical evaluations of promising innovations can be made in an otherwise decentralized diffusion system.

We now briefly describe: (1) a relatively centralized diffusion system, the agricultural extension services, (2) three relatively decentralized diffusion systems (Legitech, the Tachai agricultural model of China, and the Davis energy conservation program), and (3) a hybrid system that combines certain elements of both centralized and decentralized diffusions, the National Diffusion Network.

The Agricultural Extension Services

The fifty state agricultural extension services, operating cooperatively with the U.S. Department of Agriculture's (USDA) Federal Extension Service, represent the largest public investment in a diffusion system in the United States and in the world. The total annual budget is about $600 million, approximately equal to the yearly expenditure for agricultural research (Rogers et al, 1982a).

The usual flow of agricultural innovations is from the USDA and state agricultural experiment stations (the R&D system), to state extension specialists stationed in state agricultural universities, to county extension agents, and finally to individual farmers. The agricultural R&D workers are

Ph.Ds whose scientific products are the hybrid seeds, agricultural machinery, fertilizers, and livestock feeds that caused an agricultural revolution in America. Once an agricultural innovation reaches an individual farmer in this centralized diffusion system, horizontal transfer of the new idea passes through peer networks. Thus, the agricultural extension services are an example of a relatively (but not completely) centralized diffusion system (Figure 9-2).*

Legitech

Legitech is a computer conferencing system for the exchange of scientific and technical information among the legislative staffs of the various states (Stevens, 1980; Johnson-Lenz and Johnson-Lenz, 1979; Leonard-Barton and Rogers, 1981). A state legislator wishing to solicit suggestions for solving a problem (for example, cleaning up hazardous waste-dumping sites) can send out a general inquiry on this topic over the Legitech computer network to find how other states have responded to this problem. Legislators in other states can respond to the inquiry. The response may be a specific technical solution or a reference to print or human resources that can supply an answer. Sometimes the response is a reference to a bill originated by a legislator in another state. Other members of the Legitech network can also access answers to others' requests.

Certain information sources in Legitech have earned the respect of others on the system for their careful and competent responses to inquiries. Their reputations, in other words, establish them as innovation legitimizers, but this role is unofficial. In Legitech, state legislators or their assistants decide what their problems are. They seek further information and technical advice about an innovation to meet this problem.

Tachai: Decentralized Diffusion in China

The use of models and on-the-spot conferences are crucial elements in the diffusion of innovations in China (Rogers and Chen, 1980). A *model* is a local unit (usually a county, commune, or a production brigade) that

* A recent incident shows that even the agricultural extension services are not immune to user innovation. Bob Bergland, U.S. Secretary of Agriculture under the Carter administration, initiated research into methods of organic farming when he discovered that a respected neighbor of his in Minnesota had switched to farming his 1,500 acres with organic methods. The USDA studies revealed that, far from being the crackpots that agricultural scientists had labeled them in the past, organic farmers were often producing comparable crop yields to those raised with chemical fertilizers and sprays, and at lower cost. This finding led to a reversal of the USDA's former position of opposition to organic farming. In this case, the center followed the lead of the users. Once the idea of organic farming was accepted by the USDA, however, it was then diffused to farmers in the usual centralized fashion.

pioneers in inventing and developing an innovation, in evaluating its results, and in serving as an example for the diffusion of the innovation to other units. There are models in China for each type of diffusion: health, family planning, industrial development, and others. But without doubt the most famous model in China is Tachai Production Brigade, located in an area of rocky soil, erosion, and poor agriculture. The 90 households in Tachai Brigade operate 144 acres of this hilly land. Through the construction of stone terraces, an irrigation system, and the adoption of chemical fertilizers and other agricultural innovations, the farmers of Tachai Brigade were able to increase their grain yields eightfold from 1949 to 1971.* Even when their early efforts were destroyed by a flood, the Tachai farmers refused an offer of government assistance. This self-reliant theme of Tachai Brigade was consistent with Mao's philosophy, and in 1964 he proclaimed: "In agriculture, learn from Tachai." This slogan is reproduced thousands of times on dams, bridges, and the walls of homes and public buildings throughout China. During the 1970s, Tachai became flooded anew—this time with visitors. During 1978, when the author visited Tachai, this small village received over 400,000 pilgrims, an average of over 1,000 visitors a day, who came to learn how to grow grain and to develop self-reliance. On one record day, 30,000 individuals visited Tachai! Copies of Tachai began to sprout all over China.

Such decentralized diffusion in China is facilitated by "on-the-spot conferences." Such meetings are held at the site of a model like Tachai in order to allow participants actually to see the innovation in use by a local unit, to ask questions about how to implement the innovation and what its effectiveness has been, and to consider how the innovation might be used in the visitor's home unit. After the on-the-spot conference, the visitors report this information to their peers, who then decide whether or not to adopt the innovation, and, if they decide to adopt, how to fit it to their particular local conditions. The innovation demonstrated at the exemplary model need not be copied exactly; rather, the general concept of the innovation should be learned without slavish copying. Often a great degree of variety can be observed in the forms of an innovation that are actually implemented by local units when they return from on-the-spot conferences. In light of the heterogeneous conditions of a huge country like China, such re-invention is appropriate.

The diffusion of innovations in China is distinctive in that it is (1) more horizontal in nature, (2) less dependent upon scientific and technical expertise, and (3) more flexible in allowing re-invention of the innovation as it is implemented by local units. These aspects of decentralized diffusion are facilitated by China's use of such diffusion strategies as models and on-the-spot conferences. The "learning from others" approach to decentralized

* In 1980, the Chinese government claimed that the grain yields of Tachai Brigade had been falsified. As a result, the Tachai slogan has become less prominent in China.

diffusion in China was adopted officially as a national policy in the national constitution in 1978.

Davis: America's Energy Conservation Capital

The United States has its own Tachai at Davis, California, which the mass media have touted as a national model for community-level energy conservation. The Davis story began in 1972 when a coalition of activist citizens were elected to the city council, and began to institute a series of ordinances and policies designed to save energy. All new homes were required by a city law to be solar-heated, and any old home that was resold had to have solar water heating. Bicycle lanes were built. The city's police force switched to bicycles and compact cars. Davis was proud of its self-reliance; none of the energy-conserving innovations was funded by federal grants or by any other external means. While politicians in Washington, D.C., debated energy policies, created a U.S. Department of Energy, and spent millions for research and development on energy conservation, the people of Davis quietly went about solving their part of this national problem.

As a result of Davis' city policies and private initiative, household gas consumption was reduced by 21 percent, and electrical consumption dropped 13 percent from 1973 to 1977. By 1986, the City of Davis plans to achieve a 50 percent reduction in its total energy use from 1976. Davis' success soon attracted the attention of the mass media. A 1977 *Newsweek* article featuring Davis was entitled "The Thriftiest Town of All." This article was followed by many other articles in newspapers and news magazines, and by television programs: A *New York Times* editorial, CBS' *60 Minutes,* and NBC's *Today Show.* The *Wall Street Journal* in 1978 stated: "Davis has done more for energy conservation than any other city in the nation."

In 1978, Rosalyn Carter visited Davis and spoke approvingly of what she saw. President Jimmy Carter mentioned Davis as an example of local initiative in conserving energy during one of his energy addresses. Since then, as a Davis official told me recently, "The City Hall phone hasn't stopped ringing." In fact, the wave of visitors to Davis almost inundated this small city. During 1979, there were an estimated 2,000 site visitors, 1,500 letters, and 1,000 phone calls, making a total of about 4,500 direct contacts. Without intending to, Davis became the "model" in a decentralized diffusion system. And, as at Tachai, visitors to Davis often returned to their home communities to implement Davis-like energy conservation programs. Certainly the mass media played an important role in calling national attention to the Davis story. Further, Davis' program is self-reliant. The whole program was developed by the local community and the local city government with very little external assistance. The lack of past federal assistance has the advantage of convincing site visitors that Davis' approach could work for them too.

Overloaded by requests and underfunded for response, Davis city officials have served as unpaid change agents, explaining their story to visitors, and taking their show on the road with slides and talks. They are rewarded mainly by public recognition. The media continue to broadcast the message, "In energy conservation, learn from Davis." And the visitors continue to pour in.

Compared to the classical diffusion model, Davis would hardly qualify as a diffusion system. There is no formal R&D, nor are there any professional, full-time change agents. It is even difficult to identify exactly what the innovations are that diffuse from Davis; some of them are re-invented to such a degree that it is sometimes difficult to identify them with the Davis prototype. But certainly Davis *is* a diffusion system, perhaps one of the most important ones in the field of energy conservation in the United States. It is one of the most decentralized diffusion systems shown in Figure 9-2.

A Hybrid Diffusion System: The National Diffusion Network

To clarify further the characteristics of decentralized and centralized diffusion systems, we now describe a system that is not as decentralized as Legitech, Tachai, or Davis, but that is far more decentralized than the agricultural extension services. The National Diffusion Network (NDN) began in 1973 by a quirk of bureaucratic budget handling; officials in the U.S. Department of Education were faced with the problem of "year-end money," dollars that had to be spent by the end of the fiscal year. They decided to give the funds to local schools that had developed an innovation, to be used to spread these new ideas to other schools. About 150 such "developer/demonstrators" were funded, each horizontally to diffuse an innovation that had been approved as a "validated practice" by a committee of federal experts. The federal funds were used by the developer/demonstrators to publish brochures about their innovations, to provide training for potential adopters, and to demonstrate their innovations to other school teachers. Many of the developer/demonstrators' innovations were re-invented by other schools when they implemented them under their local conditions.

How successful is the National Diffusion Network? At the end of its first three years of operation, the 150 innovations had been accepted by several thousand adopters (Emrick with others, 1977). The NDN was very popular with school personnel, the public, and the U.S. Congress, who gave the NDN a regular budget (with a major increase to $25 million in 1977). NDN's impact was difficult to measure because so many different innovations were spontaneously flowing out from the developer/demonstrators, and because each of these innovations took such a variety of forms.

Summary

A *change agent* is an individual who influences clients' innovation decisions in a direction deemed desirable by a change agency. Change agents face two main problems: (1) their social marginality, due to their position midway between a change agency and their client system, and (2) *information overload,* the state of an individual or a system in which excessive communication inputs cannot be processed and used, leading to breakdown. Seven roles of the change agent are: (1) to develop a need for change on the part of clients, (2) to establish an information-exchange relationship, (3) to diagnose their problems, (4) to create intent to change in the clients, (5) to translate this intent into action, (6) to stabilize adoption and prevent discontinuances, and (7) to achieve a terminal relationship with the clients.

Generalizations 9-1 through 9-4 and 9-9 through 9-12 suggest that a change agent's relative success in securing the adoption of innovations by clients is positively related to: (1) the extent of change agent effort in contacting clients, (2) a client-orientation, rather than a change agency-orientation, (3) the degree to which the diffusion program is compatible with clients' needs, (4) the change agent's empathy with clients, (5) his or her homophily with clients, (6) credibility in the clients' eyes, (7) the extent to which he or she works through opinion leaders, and (8) increasing clients' ability to evaluate innovations.

Further, we propose that change agent contact is positively related to: (1) higher social status among clients, (2) greater social participation, (3) higher education, and (4) cosmopoliteness (Generalizations 9-5 through 9-8). The evidence for these generalizations is summarized in Table 9-2.

An *aide* is a less than fully professional change agent who intensively contacts clients to influence their innovation decisions. Not only do aides provide lower-cost contacts with clients (than is possible with professional change agents), but they are also able to help bridge the heterophily gap between professionals and clients, especially lower-socioeconomic clients. Aides have less *competence credibility,* the degree to which a communication source or channel is perceived as knowledgeable and expert, but they have the advantage of *safety credibility,* the degree to which a communication source or channel is perceived as trustworthy. The aide's safety credibility is due to his or her social homophily with the client system. One of the particular prob-

Table 9-2. A Summary of the Research Evidence Supporting and Not Supporting Generalizations about Change Agent Success and Contact

Generalization	Support for the Generalization (Number of Research Studies)		Percentage of Research Studies Supporting the Generalization
	Supporting	*Not Supporting*	
9-1: Change agent success is positively related to the extent of change agent effort in contacting clients.	16	3	84
9-2: Change agent success is positively related to a client-orientation, rather than to a change agency-orientation.	6	0	100
9-3: Change agent success is positively related to the degree to which the diffusion program is compatible with clients' needs.	10	0	100
9-4: Change agent success is positively related to empathy with clients.	(There are no findings available on this generalization.)		
9-5: Change agent contact is positively related to higher social status among clients.	37	6	86
9-6: Change agent contact is positively related to greater social participation among clients.	18	2	90
9-7: Change agent contact is positively related to higher education among clients.	32	11	74
9-8: Change agent contact is positively related to cosmopoliteness among clients.	5	0	100
9-9: Change agent success is positively related to homophily with clients.	2	0	100
9-10: Change agent success is positively related to credibility in the client's eyes.	1	0	100
9-11: Change agent success is positively related to the extent that he or she works through opinion leaders.	3	0	100
9-12: Change agent success is positively related to increasing clients' ability to evaluate innovations.	4	0	100

lems of aides is *inauthentic professionalism,* the process through which an aide takes on the dress, speech, or other identifying marks of a professional in his or her field.

In recent years, diffusion scholars have become aware that an alternative to the classical diffusion model exists in the form of various decentralized systems. These diffusion programs have outrun the classical model (which we now recognize was a relatively centralized approach to diffusion), and force us gradually to broaden our conceptions of diffusion. In *centralized* diffusion systems such as the agricultural extension services in the United States, overall control of diffusion decisions (such as which innovations to diffuse, how to diffuse them, and whom to diffuse them to) are made by national government administrators and technical subject-matter experts. Diffusion in decentralized systems flows in a one-way, linear direction, top-down from experts to users.

In contrast, *decentralized* diffusion systems are client-controlled, with wide sharing of power and control among the members of the diffusion system. Instead of coming out of formal R&D systems, innovations in decentralized systems come from local experimentation by nonexperts, who are often users. Local units decide which innovations should diffuse through horizontal networks, allowing a high degree of re-invention. Decentralized diffusion systems are based upon a convergence-type of communication, in which participants create and share information with one another in order to reach a mutual understanding. There are advantages and disadvantages of decentralized diffusion systems, we are beginning to realize from research on such systems, suggesting: (1) that they are most appropriate for certain conditions, and (2) that certain elements of centralized and decentralized systems can be combined to form a uniquely appropriate type of diffusion system for a particular situation.

CHAPTER 10

Innovation in Organizations

Ideas confine a man to certain social groups and social groups confine a man to certain ideas. Many ideas are more easily changed by aiming at a group than by aiming at an individual.

Josephine Klein (1961), *Working with Groups: The Social Psychology of Discussion and Decision,* p. 119.

MOST OF THE PRESENT BOOK THUS FAR has been concerned with the diffusion of innovations to *individuals.* Many innovations, however, are adopted by *organizations.* And in many cases, an individual cannot adopt a new idea until an organization has previously adopted; for example, a schoolteacher cannot use a microcomputer until the school district decides to purchase this item of equipment.

Let us briefly review our earlier discussion (in Chapter 1) of types of innovation-decisions.

1. *Optional innovation-decisions,* choices to adopt or reject an innovation that are made by an individual independent of the decisions of other members of a system.
2. *Collective innovation-decisions,* choices to adopt or reject an innovation that are made by consensus among the members of a system.
3. *Authority innovation-decisions,* choices to adopt or reject an innovation that are made by a relatively few individuals in a system who possess power, status, or technical expertise.

In addition, there are *contingent innovation-decisions,* choices to adopt or reject that can be made only after a prior innovation-decision. Thus, a doctor's decision to adopt a new medical procedure

can be made only after the doctor's hospital has decided to purchase an item of medical equipment. This example illustrates an optional decision that follows a collective decision, but other sequential combinations of two or more of the three types of innovation-decisions can also constitute a contingent decision.

Our focus in the present chapter is particularly upon collective and authority innovation-decisions, as these two types usually entail an organization as the system in which the innovation-decision occurs. Here we trace the important change from studies of organizational innovativeness, in which data were gathered typically from a large sample of organizations in order to determine the characteristics of more and less innovative organizations, to investigations of the innovation process in organizations. These latter studies, generally conducted since about the mid-1970s, are case studies of the innovation-decision process. Such a process research approach has provided important insights into the nature of the innovation process and the behavior of organizations as they change.

The innovation-process studies stress the implementation phases involved in putting a new idea into use in an organization; as such, these studies have improved upon previous diffusion research, which generally stopped short of investigating implementation by focusing on the decision to adopt or reject. The recent researches reviewed in this chapter indicate that implementation of an innovation is by no means a certainty, once the decision to adopt had been made. An compared to the innovation-decision process by individuals (Chapter 5), the innovation process in organizations is much more complicated. The latter may involve a number of individuals, each of whom plays a different role in the innovation decision.

In this chapter, we bring our study of innovations together with our understanding of the organizational context in which many innovations take place. What is an organization?

Organizations

An *organization* is a stable system of individuals who work together to achieve common goals through a hierarchy of ranks and a division of labor (Rogers and Agarwala-Rogers, 1976, p. 26). Organizations are created to handle routine tasks and to lend stability to human relationships. Their efficiency as a means of organizing human endeavors is in

part due to this stability, which stems from the relatively high degree of structure that is imposed on communication patterns. A stable and predictable organizational structure is obtained through:

1. *Predetermined goals.* Organizations are formally established for the explicit purpose of achieving certain predetermined goals. The goals for which the organization is established determine to a large extent the structure and function of the organization. For example, Troy School was established to provide a common level of training for students. This goal has much to say about the organization of the school staff.
2. *Prescribed roles.* Organizational tasks are distributed among the various positions as prescribed roles or duties. A role is a set of activities to be performed by an individual occupying a given position. Positions are the "boxes" on an organizational chart; for each position there is a prescribed role. Individuals may come and go in an organization, but the positions continue.
3. *Authority structure.* In a formal organization all positions do not have equal authority. The principal in Troy School has more authority than his department chairmen, who in turn have more authority than teachers. And the principal must obey the school superintendent and the school board. Positions are organized in a hierarchical authority structure that specifies who is responsible to whom.
4. *Rules and regulations.* A formal, established system of rules and regulations governs decision making among organizational members. There are prescribed rules and regulations for hiring new members, for promotion, for discharging unsatisfactory employees, and for coordinating the control of various activities to insure uniform operations.
5. *Informal patterns.* Every formal organization is characterized by various kinds of informal practices, norms, and social relationships among its members. These informal practices emerge over time and represent an important part of any organization. Nevertheless, the intent of bureaucratic organization is to depersonalize human relationships by standardizing and formalizing them.

Given the relative stability of organizations, one might expect that innovation would be very rare. On the contrary, innovation is going on all the time in almost every organization. We are often more aware of what is stable in an organization than we are of what is changing, and so we usually underestimate the rate of innovation in an organization. Indeed, there are many barriers and resistance to change in an organization, as we show in this chapter. But we should not forget that

innovation is one of the fundamental processes underway in organizations. Understanding the innovation process helps illuminate the nature of organizational structure and how it tends to shape individual behavior in organizational settings.

In order to begin to understand the innovation process in an organization, we describe in some detail the sequence of events, actions, and decisions through which the idea of computer scheduling of classes was initiated and implemented at a public high school.

The Rise and Fall of a Radical Innovation at Troy School*

Troy High School is located in Troy, Michigan, a fast-growing suburb of Detroit. In September 1965, the Troy School adopted "flexible modular scheduling," a revolutionary change in the school's customary procedures. This innovation, developed at Stanford University, divides the school day into twenty-four teaching modules of fifteen minutes each. Modules are combined into class periods of forty-five minutes, one hour, or one and a half hours. Each student can have a unique class schedule, and can enroll in any number of classes; about 50 percent of the student's time is unscheduled. The student is responsible for how he or she uses the school hours, including whether or not to attend classes. Each student's daily class schedule is generated by the Stanford computer. The consequences of computer scheduling were far-reaching, affecting every student, teacher, administrator, and parent connected with the Troy School.

Troy School was rated as one of the eleven most innovative schools in the United States in 1965, and was awarded a grant of $25,000 by an educational foundation to disseminate its innovations to other schools. In 1965-1966, over 1,000 visitors traveled to Troy School. They were shocked, as I was when I first stepped inside the doors in November, 1965; Troy School was *very* noisy. The halls were filled with students, some moving between one class and another. Others were simply loafing, talking, and smoking. They paid little attention to a visiting college professor and his co-researchers, who had come to Troy to conduct a communication network survey of the school staff. *

We soon met the principal, Joe Blanchard (a pseudonym), who had pioneered the introduction of the innovation shortly after his promotion from assistant principal (his six-year tenure in that post had been a happy period, with Blanchard enjoying great popularity). Within three years of our initial visit, Blanchard was to resign under pressure from the school board. Computer scheduling at Troy High School gave him nationwide recognition

* Based on Havelock et al (1974, pp. 289-296), and used by permission.

* The results of our research on diffusion networks at Troy School are reported in Lin et al (1966) and Lin (1966).

as an innovative school administrator, but the enormous impact of the innovation on the faculty, students, and the community, and the disruptive conflict that it generated, led to his removal. With Blanchard gone, the innovation of computer scheduling was soon dropped. Today there are few teachers, students, or parents who even remember Troy School's brief period of national recognition as one of the first adopters of flexible modular scheduling. In fact, today Troy School is not particularly innovative.

I selected this case illustration of the innovation process in an organization in part because I am personally acquainted with it. Joe Blanchard was a doctoral student in education at Michigan State University shortly after he left Troy School, where he enrolled in my course on the diffusion of innovations. In addition to our survey study of the teachers in the Troy School, an excellent case study was conducted of the innovation process for computer scheduling in this school by Dr. Ronald G. Havelock et al (1974). Havelock was then at the University of Michigan and is now a professor at American University. This case is unusually appropriate for present purposes because it follows the idea of computer scheduling through the innovation process to implementation and to its eventual discontinuance.

One might think that computer scheduling of classes at Troy School would amount to a fairly modest change in school procedures. On the contrary, adoption of this innovation entailed a very major alteration in almost every aspect of school activities. For instance, the innovation meant that students had to become responsible for planning the use of their time during the school day. Each of the ninety courses at Troy School had to be redesigned. Teachers had to prepare daily lesson plans collaboratively, because the innovation of flexible scheduling required team teaching of lectures and small group discussions. Further, fifty of the "incorrigible" students at Troy School were assigned to a special program that was called "Cluster C" for one and a half hours each school day. Finally, the social science teachers organized a series of invited speakers on a variety of controversial topics such as Black Power, police brutality, flying saucers, and the Viet Nam War.

I can remember sensing the strong currents of conflict and discontent among some of the school staff during our interviews back in November 1965. This conflict was later to erupt in rancorous warfare; a clique of antiinnovation teachers eventually were able to force the principal to resign.

INITIATION OF THE INNOVATION. Joe Blanchard, the newly appointed principal at Troy School, first became aware of flexible scheduling from a book that was recommended to him by an education professor at Michigan State University. The principal thus became interested in 1964, and then requested a film from Stanford University about the innovation of computer scheduling. The next step was for the principal and two staff members to fly to Chicago to meet with a Stanford University representative to discuss how the innovation might be used at Troy School. Upon their return, the prin-

cipal presented information about flexible scheduling to the faculty, and a collective decision was made to adopt. Only a small clique of thirteen teachers opposed the innovation in the total faculty of thirty-five. With this positive decision in hand, the principal approached the school board for their approval, which was granted. The superintendent was out of town at the time of the board meeting, but he had expressed his approval the preceding week. Then the idea of flexible scheduling was explained to the students at a school assembly; they liked the idea. Parents were invited to a series of meetings about the innovation, although only about 1 percent attended. So by the end of the 1964-1965 school year, Troy School was ready to adopt the innovation.

IMPLEMENTING THE INNOVATION OF COMPUTER SCHEDULING. Classes began in September 1965, and problems with flexible scheduling were encountered almost immediately. When students discovered they did not have to go to classes, "non-attendance became infectious" (Havelock et al, 1974, p. 308). Parents began to complain about their children cutting classes. At first, the Troy School teachers tried lecturing the students about their new responsibility. It did not improve attendance. Finally, a tracking system was established, so that teachers could know which students should be in class at any particular time of day. Further, students who received three or more failing grades in their classes were placed in study halls during their free time. Freedom became a reward for satisfactory performance in class.

Another problem was the large number of teachers, school administrators, and community leaders who flocked to Troy School to observe computer scheduling, which was the first adoption of this innovation outside of California. At first, Troy's teachers and students felt complimented by the hordes of visitors, but soon they began to feel these site visitors were getting underfoot and interfering with the effectiveness of teaching and learning. (Such interference with daily operations at an innovative site by visitors is a common problem in decentralized diffusion systems, as we showed in Chapter 9.)

Most teachers, however, were enthusiastic about the innovation, and worked hard to make it a success. A tight-knit, dedicated group emerged, composed of about twenty teachers and counselors who were highly involved with the innovation. They voluntarily stayed after school almost every day to discuss the impacts of computer scheduling and how to plan for more effective use of the new program. The superintendent divorced himself from the innovation, at least until parental complaints began to come in.

These complaints became especially numerous during 1966-1967, the second year of adoption. Much of the controversy centered in the Cluster C training program for problem students. The principal, Joe Blanchard, later admitted that he had made a mistake in not involving the entire school staff in the decision to start Cluster C. Rumors abounded at Troy School about what went on in the training sessions. Several dissatisfied teachers complained to the school board, which halted Cluster C in March 1967. But the principal convinced several board members to change their position, and Cluster C was reinstated in April.

The other controversial issue during the 1966-1967 school year concerned the guest speakers program. It was rumored that George Lincoln Rockwell, head of the American Nazi Party, had lectured at Troy School (he had not), and some horrified citizens demanded that the school board discontinue the speakers' program. Principal Blanchard called an open meeting of the community to discuss the issue, and 300 attended, mostly supporting the program. As a result, the school board voted four to three to reinstate the speakers' program. But in the spring, John Sinclair, founder of the White Panthers, a radical left-wing group, appeared at Troy School. The Troy newspaper carried a story about his speech. Many citizens were disturbed, and the school was swamped with phone calls protesting the incident.

The controversy over flexible scheduling at Troy School boiled on during the summer of 1967. The local newspaper carried a page of letters to the editor about the innovation. The chairperson of the social studies department at Troy School wrote: "Our present day situation is due to a mindless adherence to misunderstood principles." Principal Blanchard was blamed for the controversy surrounding the school's problems with the innovation of computer scheduling. At its June 13th meeting, the school board placed the principal on one-year probation with the terms that all students had to attend classes and that the Cluster C program be discontinued. In July, the school board rejected a three-year grant of $120,000 from the federal government, and also voted against continuation of the foundation grant that had brought many visitors to Troy School, making it what they called "a fish bowl." The dissident clique of teachers tried to force the principal to resign, but the school board voted four to three to retain him. Nevertheless, Joe Blanchard was becoming fatigued with the controversy about the innovation, and in late September 1967, he resigned to accept a job offer at another innovative school.

He was replaced by a new principal, who aligned himself with the minority clique of teachers opposing flexible scheduling. But a majority of the staff still supported the innovation, and it was continued during its third year, although on a modified basis.

During the fourth year, 1968-1969, however, the school superintendent resigned, feeling that he was no longer trusted by those opposing the innovation. In fact, he had been accused of mishandling funds, although this charge was not substantiated. In early spring 1969, the news was released that the achievement test scores of Troy students were declining, and flexible scheduling was blamed for this poor student performance. In March 1969, the school board voted to discontinue the innovation. But after a public hearing, the board reversed its decision and reinstated flexible scheduling.

But by fall 1969, the innovation's supporters were losing their desire to

continue fighting for the innovation. School funding was inadequate, owing to the failure of a community school bond issue, and skyrocketing enrollments forced Troy School to go into half-day sessions. The school board voted to discontinue computer scheduling after the 1969-1970 school year, the innovation's fifth year. Today, a decade or so later, very few individuals in Troy, Michigan, even remember that their school was once a superinnovator.

Why did computer scheduling fail at Troy School?

1. The technology was not very well developed at the time that Troy School adopted in 1965. Joe Blanchard and his staff implemented computer scheduling without ever seeing it in use in a school (the earlier adopters were all in faraway California). Troy first adopted the innovation without modification (although much re-invention occurred later), and it was probably too radical a change for a previously conventional school like Troy. The incompatibility was greatest for the outside speakers, the Cluster C program for problem students, and for the free time that was given students. Actually, none of these elements of the innovation cluster was a necessary component (in fact, many other Midwestern schools who visited Troy did *not adopt* these elements when they adopted computer scheduling).

For example, the student freedom in using their out-of-class time just evolved because no adequate means of tracking attendance had been planned for when flexible scheduling was begun. Cluster C was a success for the problem students participating in it, as most of them learned to enjoy school. But on the last day of school in 1966, a student in Cluster C was seen to hug a teacher to say goodbye; three teachers in the antiinnovation clique observed this event, and rumors about Cluster C began to fly. The innovation of computer scheduling was blamed by the opponents to Cluster C.

2. The innovation was widely misunderstood, and in fact was blamed for anything that went wrong at Troy School. When acts of vandalism increased, flexible scheduling was considered the cause, because of the free time it provided to students. When student achievement scores dropped, flexible scheduling was blamed, although some observers said the test did not measure what Troy School was trying to teach. These misunderstandings arose, in part, because the innovation was implemented rapidly, and some teachers, many students, and most of their parents did not fully comprehend in advance the far-reaching consequences that would occur.

3. The school board and the superintendent, key gatekeepers * for the innovation, did not participate fully in the innovation process through which computer scheduling was introduced at Troy School. Joe Blanchard became so enthused about the innovation that he did not give enough effort to helping the powerful school board and superintendent participate in the innovation process. Nor did he fully appreciate the unfavorable consequences that would arise from the innovation. But he gained a nationwide reputation as an innovative school administrator, and when he resigned at Troy, he was offered attractive jobs at other schools.

4. The communication structure of the school staff at Troy School was not understood adequately by Principal Blanchard nor by other activists for the innovation. The minority clique of thirteen teachers opposed computer scheduling from the beginning; eventually their numbers grew until they became powerful enough to express their dismay with the innovation to the school board, which eventually voted to drop the innovation.

Notice in this case illustration that most of the problems with computer scheduling only began at the implementation phases of the innovation process. If diffusion scholars like Havelock and others (1974), Lin (1966), and Lin et al (1966) had investigated only the initiation steps in the innovation process, leading to the decision to adopt, much of the really interesting behavior would have been missed.

* *Gatekeeping* is the communication behavior of an individual or individuals who withhold or reshape information that they control as it flows into their system.

Organizational Innovativeness

Diffusion research began with investigations of individual decision makers such as farmers, as we know from Chapter 2. When this paradigm was extended to medical doctors and teachers, the early diffusion studies ignored the fact that teachers are school employees and that most doctors work in hospitals or in a group practice. Finally, in the 1960s, we began to see diffusion studies in which the unit of adoption was an organization, rather than an individual. But these early studies of organizational innovativeness were very incomplete and oversimplified in that the data were just obtained from a single individual (usually the chief executive); in essence, each organization in these diffusion studies was reduced to the equivalent of an individual.

There was a tendency until the 1970s simply to transfer to the study of organizations the models and methods of innovativeness originally developed for individuals, often without carefully thinking through the ways in which the two levels of systems were alike or unalike (Eveland, 1979). In retrospect, I think that Professor Neal Gross et al (1971, p. 22) may have been correct when (about ten years ago) they stated: "In short, while Rogers' [classical] diffusion model may be useful in understanding the adoption of simple innovations among aggregates of individuals, it appears to be of little value for explaining the implementation of organizational innovations."

Several hundred studies of organizational innovativeness were completed before I began to lead an intellectual revolt against them.

During the 1970s, a different kind of diffusion research began to be conducted in organizations, looking *within* the organization at the innovation process. Instead of determining the variables related to more innovative and less innovative organizations, we began to trace the process of innovation within an organization. This was *process research,* a type of data gathering and analysis that seeks to determine the time-ordered sequence of a set of events (Chapter 5). In contrast, the earlier studies of organizational innovativeness were *variance research,* a type of data gathering and analysis that consists of determining the co-variances among a set of variables, but not their time-order.

By no means do we completely deprecate these 1960s studies of organizational innovativeness. Indeed, researchers like Mohr (1969) and several hundred others helped illuminate the characteristics of innovative organizations; many of these characteristics were the equivalent of the characteristics of innovative individuals. For example, larger-sized organizations are more innovative, just as are individuals with larger incomes and higher socioeconomic status. But certain of the organizational characteristics do not have an individual counterpart; for instance, organizational structural characteristics like system openness * and formalization* were found to be related positively and negatively, respectively, to organizational innovativeness. So ther6 was a fair degree of conceptual originality in the organizational innovativeness studies, even though their research methodologies were copied from the individual-level diffusion studies.

Shortcomings of Organizational Innovativeness Studies

After several hundred studies of organizational innovativeness were completed, this approach to innovation in organizations generally became passe. Why?

1. The organizational innovativeness studies found rather low relationships between the independent variables that were investigated and the dependent variable of innovativeness. Because of the rather large sample size (often a hundred or more organizations), the typical

* *System openness* is the degree to which the members of a system are linked to others who are external to the system. An open system exchanges information across its boundaries.

* *Formalization* is the degree to which an organization emphasizes following rules and procedures in the role performance of its members.

organizational innovativeness study had to follow a highly quantitative approach to data analysis. Independent variables like such organizational structure dimensions as centralization, formalization, and the like were measured for each organization. The dependent variable of innovativeness was typically measured as a composite score, composed of the adoption of from ten to twenty innovations. The innovation process for each such innovation was thus submerged through aggregation into an overall innovativeness score for each organization. As a result, differences among the innovations were lost. The cross-sectional approach to data analysis also meant that time as a variable was lost; thus, the "process" (that is, the over-time) aspects of the innovation process could not be measured.

In fact, the organizational innovativeness studies could not have been designed more appropriately to *preclude* understanding the innovation process in organizations. They were appropriately designed and conducted to determine the characteristics of more and less innovative organizations. But the results mainly showed that: "Attributes of organizational structure are by no means the sole determinants of innovation adoption" (Kervasdoue and Kimberly, 1978). The relatively modest correlations of organizational structure variables with innovativeness at least helped establish the futility of understanding innovation in organizations through innovativeness surveys.

2. One of the vexing problems of the organizational innovativeness studies was how adequately the data provided by the chief executive represented the innovation behavior of the relevant members of the organization. Certainly there is no reason to expect consensus about the adoption of an innovation on the part of even the top leaders in an organization, let alone to expect complete agreement between management and the workers in an organization.

Because the organizational innovativeness studies typically gathered data only from the top executive of each organization in a sample of organizations, there was no way to determine how adequately these data truly represented the entire organization's behavior with regard to a technological innovation. Bingham and Frendreis (1978) gathered questionnaire data from eight city officials (the chief administrator, finance officer, police chief, etc.) in each of 276 U.S. cities about the adoption of three planning/budgeting innovations. One would expect that the chief executive and the finance officer would agree about such a basic matter as to whether adoption of an innovation had occurred or not. But such agreement between these two top officials was only 86 percent for the innovation of zero-base budgeting, 70 percent for pro-

gram planning and budgeting (PPBS), and 60 percent for program budgeting.

The question troubling any diffusion scholar who depends solely on data from the top leader in an organization is how fully such information can describe the organization's innovation behavior. Not very fully, the available evidence suggests.* The remedy, of course, is to follow a multiple-respondent data-gathering design, as Bingham and Frendreis (1978) did, or, better yet, a multimeasurement approach in which interview, archival, and other data are gathered about the innovation-decision progress in an organization.

Such an in-depth approach means that only a much smaller sample of organizations can be studied with the same research resources, and hence there is less basis for generalizations of the research results. But in return such an in-depth approach provides more reliable data and permits greater insight in tracing the nature of the innovation process in each organization. This type of research design follows a process approach rather than a variance approach. The researcher learns more about less, rather than less about more. Given our present rather limited understanding of innovation in organizations, the in-depth approach of process research is more appropriate.

Size and Organizational Innovativeness

The size of an organization has consistently been found to be positively related to its innovativeness. For instance, Mytinger (1968, p. 7) asked: "Is [innovativeness due to] the man, the agency, or the place?" The innovativeness of forty local health departments in California was related to (1) their bigness in staff and budget, which in turn rested on (2) the size of the city they served, and (3) the cosmopoliteness, accreditation, and prestige of the health director among his or her peer health officials. Overall, "This study suggests that *size*—size of community and size of [the health] department—is perhaps the most compelling concomitant to innovativeness" (Mytinger, 1968, p. 7).

Similar evidence for the importance of size as a predictor of organizational innovativeness is provided by Mohr (1969), Kaluzny et al

* Just how fully, of course, would depend on how many individuals in an organization are actually involved in an innovation decision. Not very many individuals are involved in such decisions in public organizations, several studies suggest (Rogers et al, 1977a; Rogers et al, 1979b; Bingham, 1976). And in most cases, the chief executive was not very directly involved in the innovation process. So depending solely on his or her perceptions of the innovation process would be dangerously incomplete.

(1973), Mansfield (1963), and several others.* Why do researchers consistently find that size is one of the best predictors of organizational innovativeness? First, size is a variable that is easily measured, and presumably with a relatively high degree of precision. So size has been included for study in almost every organizational innovativeness investigation.

Second, size is probably a surrogate measure of several dimensions that lead to innovation: total resources, slack resources, organizational structure, and so on. These unidentified variables have not been clearly understood, or adequately measured in most researches. Undoubtedly these unmeasured variables are a fundamental, and intellectually deceiving, reason for finding that size and innovativeness are related. Few scholars have much theoretical interest in size as a variable, but it is a convenient stand-in variable for other variables of interest. Its effects on innovativeness through the yet-unidentified intervening variables should be isolated and understood.

So, good-bye size. Or at least turn it over, and see what lies underneath.

Structural Characteristics and Organizational Innovativeness

During the 1960s and early 1970s, innovativeness was related to independent variables measuring certain dimensions of organizational structure: centralization, complexity, formalization, and openness. Figure 10-1 shows these structural variables, plus certain individual variables, that were found to be associated with organizational innovativeness. We divide these independent variables into three classifications: (1) individual (leader) characteristics, (2) internal organizational structural characteristics, and (3) external characteristics of the organization.

Here we look at the organizational structure variables related to the innovativeness of organizations.

Centralization is the degree to which power and control in a system are concentrated in the hands of relatively few individuals. Centralization has usually been found to be negatively associated with innovativeness; that is, the more power is concentrated in an organization,

* On the other hand, in private firms it has often been observed that small-sized organizations are more inventive in developing new technological products (U.S. General Accounting Office, 1981).

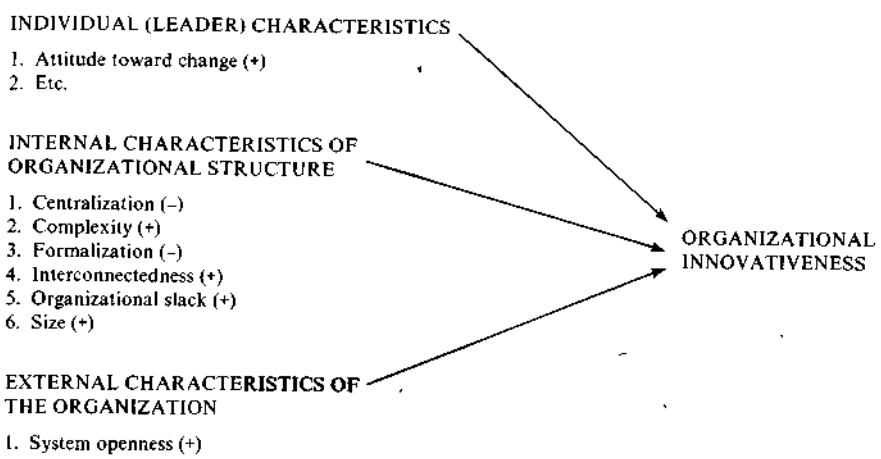

Figure 10-1. Independent variables related to organizational innovativeness.

Several hundred researches were completed on variables related to organizational innovativeness. Rather modest correlations, however, were generally obtained between these independent variables and organizational innovativeness. Since about the mid-1970s these studies of organizational innovativeness have been largely replaced with process research on innovation in organizations.

the less innovative that organization tends to be. The range of new ideas in an organization seems to be restricted when a few central leaders dominate the scene. Although the initiation of innovations in a centralized organization is less frequent than in a decentralized organization, the centralization may actually encourage the implementation of innovations, once the innovation decision is made. In a centralized organization, top leaders are poorly positioned to identify operational problems, or to suggest relevant innovations to meet these needs.

Complexity is the degree to which an organization's members possess a relatively high level of knowledge and expertise, usually measured by the members' range of occupational specialties and their degree of professionalism expressed by formal training. Complexity encourages organizational members to conceive and propose innovations, but it may make it difficult to achieve consensus about implementing them.

Formalization is the degree to which an organization emphasizes

following rules and procedures in the role performance of its members. Such formalization acts to inhibit consideration of innovations by organization members, but encourages implementation of innovations.

Interconnectedness is the degree to which the units in a social system are linked by interpersonal networks. New ideas can flow more easily and rapidly among an organization's members if it has higher interconnectedness, and this variable is positively related to organizational innovativeness.

Organizational slack is the degree to which uncommitted resources are available to an organization. This structural variable is positively related to organizational innovativeness: "Slack provides a source of funds for innovation that would not be approved in the face of scarcity" (Cyert and March, 1963, pp. 278-279).

When we look at the results of the several hundred studies of organizational innovativeness, the general picture is one of rather low correlations of each of the independent variables in Figure 10-1 with the innovativeness of organizations. The basic reason for these disappointing results is that each of the organizational structure variables is related to innovation in one direction during initiation, and in the opposite direction during implementation. Low centralization, high complexity, and low formalization facilitate initiation in the innovation process, but these same structural characteristics make it difficult for an organization to implement an innovation (Sapolsky, 1967; Zaltman et al, 1973). Thus, we see how bringing the initiation and implementation subprocesses of the innovation process into our analysis helps explain the results of past research on correlates of organizational innovativeness. In this case, following a process research approach (to understanding the sequence of the innovation process) helps illuminate a paradox in the correlates of organizational innovativeness (the rather disappointing prior results obtained from variance research).

Stages in the Innovation Process in Organizations

Previously we have shown how the oversimplified nature of past studies of organizational innovativeness failed to capture the complex, over-time nature of the innovation process in organizations. Since the mid-1970s, this process has been traced by diffusion scholars

who have identified the main sequence of decisions, actions, and events by means of synthesizing the recallable perceptions of key actors in the innovation process, written records, and other data sources. This research on innovation in organizations follows a process approach, as opposed to the variance approach of the cross-sectional surveys of organizational innovativeness.

A Model of the Innovation Process in Organizations

The innovation process consists of a usual sequence of five stages, each characterized by a particular range of events, actions, and decisions made at that point. Later stages in the innovation process cannot be undertaken until earlier stages have been settled, either explicitly or implicitly. The five stages in the innovation process are described in Table 10-1.

1. AGENDA-SETTING

Strictly speaking, agenda-setting is continuously underway in every organization, and is not part of the innovation process proper. We aid understanding of the innovation process, however, by considering agenda-setting as part of the sequence, for it is here that the initial motivation is generated to impel the later steps in the innovation process.

Our view of agenda-setting implies that one or more individuals in an organization identify an important problem and then seek an innovation as one means of coping with the problem. *A performance gap* is the discrepancy between an organization's expectations and its actual performance. This difference between how an organization's members perceive its performance, in comparison to what they feel it should be, can be a strong impetus to search for an innovation.

On the other hand, most organizations engage in an opportunistic surveillance by scanning the environment for new ideas that might be beneficial to the organization. As March (1981) noted, innovation in organizations "often seems to be driven less by problems than by solutions. Answers often precede questions." Most organizations face many problems, but possess knowledge of only a few innovations that offer solutions. So the chance of identifying an innovation to cope with a particular problem is small. But if one begins with a solution, there is a good chance that the innovation will match some problem

Table 10–1. Stages in the Innovation Process in Organizations

Stage in the Innovation Process	Major Activities at Each Stage in the Innovation Process
I. *Initiation:*	All of the information-gathering, conceptualizing, and planning for the adoption of an innovation, leading up to the decision to adopt.
1. AGENDA-SETTING	General organizational problems, which may create a perceived need for an innovation, are defined; the environment is searched for innovations of potential value to the organization.
2. MATCHING	A problem from the organization's agenda is considered together with an innovation, and the fit between them is planned and designed.
The Decision to Adopt	
II. *Implementation:*	All of the events, actions, and decisions involved in putting an innovation into use.
3. REDEFINING/RESTRUCTURING	(1) The innovation is modified and re-invented to fit the situation of the particular organization and its perceived problem, and (2) organizational structures directly relevant to the innovation are altered to accommodate the innovation.
4. CLARIFYING	The relationship between the innovation and the organization is defined more clearly as the innovation is put into full and regular use.
5. ROUTINIZING	The innovation eventually loses its separate identity and becomes an element in the organization's ongoing activities.

that is facing an organization. Consequently, most organizations continuously scan for innovations, and match any promising innovation found with some relevant problem.

Evidence supporting the notion that awareness of an innovation launches the innovation process in an organization is provided by Eveland et al (1977), Rogers et al (1976), and several other investigators. For instance, on the basis of her study of the adoption of individualized instruction in six schools in the Philippines, Bernas (1981,

p. 71) concluded: ''The awareness of the availability of individualized instruction created a demand for the innovation itself." In Chapter 5 we noted that individuals may begin the optional innovation-decision process by becoming aware that a new idea exists, and then finding that they have a need for it. Here we see that a parallel sequence often launches the innovation process in an organization.

So the process can be either problem-initiated or innovation-initiated. It is frequently the latter.

On the basis of his analysis of how new laws are passed by the U.S. Senate, Walker (1977) concluded: "Those who manage to shape the legislative agenda, in other words, are able to magnify their influence many times over by determining the focus of attention and energy in the entire political process." The agenda-setting role in any organization is a tremendously powerful one.

2. MATCHING

At this stage in the innovation process, conceptual matching of the problem with the innovation occurs in order to establish how well they are likely to fit. This is a kind of reality testing in which the organization attempts to test the feasibility of the innovation in solving the organization's problem. Such symbolic trial entails thinking about the anticipated problems that the innovation might encounter if it were implemented. Of course, the organization's decision makers may conclude that a mismatch of the innovation with the problem would occur; this decision will lead to rejection, terminating the innovation process prior to implementation.

The agenda-setting and the matching steps in the innovation process together constitute *initiation,* defined as all of the information gathering, conceptualizing, and planning for the adoption of an innovation, leading up to the decision to adopt. So this decision marks the watershed in the innovation process between initiation and *implementation,* defined as all of the events, actions, and decisions involved in putting an innovation into use. Implementation consists of three stages.

3. REDEFINING/RESTRUCTURING

At this stage, the innovation imported from outside of the organization gradually begins to lose its foreign character. On the one hand, if

the innovation does not exactly fit the organization's situation, it is re-invented so as to accomodate the organization's needs and structure more closely. As pointed out in Chapter 5, re-invention was not really recognized as a frequently occurring kind of behavior until diffusion scholars began to investigate the innovation process in organizations. Once researchers began to use process research, and to study innovation in organizations, they began to encounter a good deal of re-invention behavior.

Not only is the innovation modified to fit the organization, the structure of the organization may have to be changed to accommodate the innovation. Sometimes a new organizational unit is created with responsibility for the innovation; for instance, when an organization installs a new computer or data-processing equipment. In other cases, the innovation may affect the structure of the entire organization, such as when an electronic messaging system is introduced.

4. CLARIFYING

Gradually the innovation is put into wider use in the organization, and as this happens the meaning of the new idea becomes clearer to the organization's members. As our later case illustration shows, too-rapid implementation of an innovation at the clarifying stage can lead to disastrous results. Misunderstandings or unwanted side effects of the innovation may occur, but if identified, corrective action can be taken. Stable arrangements are now made for the innovation; it is becoming imbedded in the organizational structure.

5. ROUTINIZING

At this stage the innovation has become incorporated into the regular activities of the organization, and the innovation loses its separate identity. We should not forget that discontinuance of the innovation can occur during the routinizing stage; such deimplementation was described previously for the innovation of computer scheduling at Troy School.

Time Sequence of the Stages in the Innovation Process

The five stages just described usually occur in the order presented, but this need not happen. That is, until the activity at one stage is substan-

daily accomplished, at least implicitly, the next stage cannot begin. The innovation process may move slowly or rapidly; it may even backtrack as previously unrecognized problems are revealed. And it is possible that one or more of the stages in the innovation process might be skipped.

Unfortunately, only a dozen or so investigations of the innovation process in organizations have been completed to date, and so evidence is somewhat scanty as to whether or not the stages occur in the order specified in our model. Table 10-2 diagrams the stages in the innovation process for computer scheduling in Troy School, our previous case illustration. The most convincing support for our proposed sequence is provided by Pelz (1981), who investigated the time-order for a set of stages rather like ours for three innovations (energy conservation, solid waste processing, and noise control) that were each adopted by eighteen U.S. cities and counties. The innovation-process stages usually occurred in the expected time-order when the innovation was imported by the organization from external sources. But when the innovation originated within the organization, the stages in the innovation process appeared muddled and overlapping.

Implementation that Failed: Starting Too Big*

There are many problems that can impede or terminate the implementation of an innovation in an organization. One of them is to start too big. An immediate move to full implementation of an innovation may lead an organization to neglect important stages in the innovation process. For example, if the clarifying stage is rushed, the routinizing stage may never occur because of the implementation problems that may arise.

Dial-A-Ride is a form of demand-responsive transportation characterized by the traveler's telephoning for a bus, van, or cab, as he or she needs a ride. During the 1970s, Dial-A-Ride diffused rapidly throughout the United States as one solution to certain urban mass transportation problems. By mid-1978, over 300 local organizations in the United States had adopted Dial-A-Ride.

Without doubt, the most widely known experience with too-rapid implementation of Dial-A-Ride is that of Santa Clara County in California. Dial-A-Ride was initiated by the county transit district on November 24, 1974, and began full service on December 21, 1974. It was to serve the entire county of about 1,200,000 people, a high-density area centered in San Jose. This adoption of Dial-A-Ride was the largest ever attempted at that time in the United States (Carlson, 1976).

* Adopted from Rogers et al (1979b) and used by permission.

The high public expectation for Dial-A-Ride was quickly dashed. On the first day of full service, a Sunday, about 50,000 telephone calls for Dial-A-Ride were received. This high demand swamped the capacity of the local telephone system. By the following Wednesday, virtually everyone in the county had a horror story to tell regarding the telephone communication system. The stated objective of the Dial-A-Ride system, a five- to ten-minute waiting period, would have required at least 210 Dial-A-Ride vehicles; fewer than 75 were available on any given day. The unreliability of the Dial-A-Ride service left some riders stranded in remote places in the county; their bitter letters were published in the local newspaper. The crisis was exacerbated when the Santa Clara County Superior Court ruled that the county transit district would have to discontinue Dial-A-Ride or begin negotiations immediately to buy out the eight competing taxi companies operating in the county. On May 9, 1975, Dial-A-Ride in Santa Clara County was discontinued (except for a small Dial-A-Ride operation with six vehicles in a small area of the county) after five and one-half months of troubled operation.

A post-mortem evaluation by Carlson (1976) identified four "fatal mistakes": (1) the starting of the entire Dial-A-Ride system at once, (2) an inadequate customer communication system, (3) an inadequate number of vehicles, and (4) the taxi company buyout. The first mistake was a critical one; the county government's decision to serve the entire county from the first day that service was offered meant that "all mistakes had large impacts, and all problems were system-wide from the beginning" (Carlson, 1976).

Why wasn't Dial-A-Ride implemented on a sequential basis in the case of Santa Clara County? Transportation planners in Santa Clara County actually had recommended gradual implementation, but for political reasons, the county board of supervisors ignored this recommendation (as well as a recommendation to constrain demand by charging a premium fare). They felt that it would be politically infeasible to tell county residents that a new transportation system would be available only in a limited section of the county, even though all residents would be paying for it (Carlson, 1976).

The negative lesson from Santa Clara County was not lost on the many cities that later adopted Dial-A-Ride: There are serious perils in implementing an innovation in a way that permits immediate, highly visible, system-wide breakdown. The fear of being involved in a large-scale public disaster clearly motivated many later adopters to implement Dial-A-Ride gradually.*

Information about the spectacular collapse of Santa Clara County's Dial-A-Ride spread quickly, although almost no written materials concerning it were available. Large numbers of visitors from various U.S. cities, and from Europe, Australia, and Japan, visited San Jose to discuss the ex-

* Evidently, the Santa Clara County lesson was not fully appreciated by the "Dial-A-Santa" program in Wichita in December 1976. About 7,000 telephone calls were received the first hour, which "blew" the local telephone system, and led to discontinuance of the innovation.

Table 10-2. Classifying the Adoption of Computer Scheduling at Troy School by Stages in the Innovation Process

	STAGES IN THE INNOVATION PROCESS				
	Initiation		*(Decision)*	*Implementation*	
SCHOOL YEAR	1. AGENDA-SETTING	2. MATCHING	3. REDEFINING/ RESTRUCTING	4. CLARIFYING	5. ROUTINIZING
1964–1965	(1) Principal feels that Troy School needs a major change; looks for radical innovation. (2) Professor gives principal a book about computer scheduling.	(1) Principal requests film about innovation. (2) Principal travels to Chicago to discuss the innovation with a Stanford representative.	(1) Staff approves of the innovation. (2) Superintendent and school board approve.		
1965–1966			(1) Computer scheduling is explained to students and parents. (2) Class absences force school to establish tracking system.		
1966–1967				(1) Problems arise with Cluster C and with guest speakers' programs.	
1967–1968				(2) Principal resigns.	
1968–1969				(3) Superintendent resigns.	
1969–1970				(4) Low achievement test scores at Troy School. (5) Shortage of school funds and spurting enrollment force half-day sessions. (6) School board votes to discontinue computer scheduling.	(The innovation is not routinized).

perience. Widespread awareness of Santa Clara County's Dial-A-Ride was achieved almost entirely by word of mouth, through the interpersonal networks of transportation professionals.

Summary

An *organization* is a stable system of individuals who work together to achieve common goals through a hierarchy of ranks and a division of labor. Although behavior in organizations is relatively stable, innovation is going on all the time.

Until about the mid-1970s, innovation in organizations was mainly studied by means of variance research; independent variables were correlated with organizational innovativeness in cross-sectional data analysis. The chief executive in an organization was asked to provide information in these large-scale surveys. Rather low relationships of characteristics variables with organizational innovativeness were found, and today this type of research is largely passe.

It has been replaced by process research on the innovation process in organizations. We divide the innovation process into (1) *initiation*, all of the information gathering, conceptualizing, and planning for the adoption of an innovation, leading up to the decision to adopt, and (2) *implementation*, all of the events, actions, and decisions involved in putting an innovation into use. The two initiation stages are agenda setting and matching, and the three implementation stages are redefining/restructuring, clarifying, and routinizing.

CHAPTER 11

Consequences of Innovations

Changing people's customs is an even more delicate responsibility than surgery.

Edward H. Spicer (1952), *Human Problems in Technological Change,* p. 13.

CONSEQUENCES ARE THE CHANGES that occur to an individual or to a social system as a result of the adoption or rejection of an innovation. An innovation has little effect until it is distributed to members of a system and put to use by them. Thus, invention and diffusion are but means to an ultimate end: the consequences from adoption of an innovation. .

In spite of the importance of consequences, they have received very little study by diffusion researchers. Further, the data that we have about consequences are rather "soft" in nature; many investigations are case studies, although in recent years survey researchers are also studying consequences. Lack of research attention and the nature of the data make it difficult to generalize about consequences. We can describe consequences and establish categories for classifying consequences, but cannot predict when and how these consequences will happen.

Not only have researchers given little attention to consequences, change agents have as well. They often assume that adoption of a given innovation will produce only beneficial results for its adopters. This assumption is the pro-innovation bias, discussed in Chapter 3. Change agents should recognize their responsibility for the consequences of the innovations that they introduce. They should be able to predict the advantages and disadvantages of an innovation before introducing it to their clients, but this is seldom done.

The introduction of snowmobiles to Lapp reindeer herders in Northern Finland illustrates the difficulty of predicting the effects of technology. Every innovation produces social and economic reactions that run throughout the social structure of the client system.

The Snowmobile Revolution in the Artie*

In the United States we think of the snowmobile as an important instrument for winter recreation. Since the invention of the "Ski-Doo," a one-person snow vehicle, by Joseph-Armand Bombadier of Quebec in 1958, the adoption of snowmobiles spread dramatically, and within a dozen years over a million were in use in North America. Some outcry against the ski-doo (which became a generic name for snowmobiles) was voiced, owing to the noise pollution they caused in previously peaceful outdoor areas of the United States and Canada.

But among the Skolt Lapps, a reindeer-herding people in Northern Finland who live above the Artie Circle, the rapid introduction of snowmobiles caused far-reaching consequences that an anthropologist who studied them termed "disastrous" (Pelto, 1973). We seek to recapture something of the play-by-play course of events in our present account, in order to illustrate one method of investigating the consequences of technological innovation. In this approach, as in many other investigations of consequences, a social scientist (usually an anthropologist) intensively, studies a small and isolated community. Dr. Pertti Pelto of the University of Connecticut had lived among the Skolt Lapps in the Sevettijarvi region of Northern Finland for several years, beginning in 1958, prior to the introduction of snowmobiles in 1962-1963. Pelto returned to this community repeatedly over the next decade in order to assess the impact of the snowmobile revolution through participant observation, personal interviews with the Lapps, and via collaboration with a research assistant/key informant (who was the first Skolt Lapp to buy a snowmobile). Pelto chose to concentrate on a single technological innovation because its consequences were so striking and hence relatively easier to trace. Many of these impacts were unfavorable. Pelto argues that the snowmobile is representative of a class of technological innovations that shift energy sources from local and autonomous origins (for example, reindeer sleds in this case) to a dependence upon external sources (snowmobiles and gasoline).

Prior to the introduction of snowmobiles, the Skolt Lapps depended upon the herding of semidomesticated reindeer for their livelihood. Along with fish, reindeer meat was the main food. Reindeer sleds were the principal means of transportation, and reindeer hides were used for making clothing

* The present account of the consequences of the snowmobile among the Skolt Lapps is based upon Pelto (1973), Pelto and Muller-Wille (1972), and Pelto et al (1969).

and shoes. Surplus meat was sold at trading stores for cash to buy flour, sugar, tea, and other staples. The Lapps saw themselves mainly as reindeer herders, and prestige was accorded men with good strings of draught reindeer. Lapp society was an egalitarian system in which each family had approximately equal numbers of animals. Skolt children received a "first tooth reindeer," a "name-day reindeer," and gifts on other occasions, including wedding gifts of reindeer, so that a new household began with a small herd of the beloved animals. The Lapps felt a special relationship with their reindeer, and treated them with much care. Certainly the reindeer was the central object in Lapp culture.

In late 1961 a Bombadier Ski-Doo from Canada was displayed in Rovaniemi, the capital city of Finnish Lapland. A schoolteacher purchased this snowmobile for recreational travel, but soon found that it was useful for hauling wood and storebought supplies. Snowmobiles soon were used for reindeer herding by Lapps living just to the north of Sevettigarvi, where the terrain consisted of a treeless tundra. Within a year (in 1962-1963), two ski-doos were purchased for reindeer herding in Sevettigarvi, where the land was forested and rocky. The Lapp reindeer-men had to drive their machines by standing up on the footboards or else by kneeling on the seat, instead of riding in the usual straddle position (like on a motorcycle). Snowmobiles were designed for recreational use, and the Lapps had to drive them erect so that they could spot reindeer at a greater distance and so as to steer around rocks, trees, and other obstacles. But the erect riding style of the Lapps was dangerous when they hit an obstruction, as the driver was thrown forward. Breakdowns of the snowmobiles occurred often in the rough terrain of Sevettigarvi.

Despite these problems, the rate of adoption of snowmobiles was very rapid among the Lapps. Three snowmobiles were adopted the second year of diffusion (1963-1964), five more in 1964-1965, eight more in 1965-1966, and then sixteen in 1966-1967; by 1971, almost every one of the seventy-two households in Sevettigarvi had at least one snowmobile. 1966-1967 was a landmark year in which the rate of adoption of the innovation spurted, in part because an improved model, the Motoski, was introduced from Sweden. It had a more powerful motor and was better suited to driving in rough terrain.

The main advantage of the snowmobile was much faster travel. The round trip from Sevettigarvi to buy staple supplies in Norwegian stores was reduced from three days by reindeer sled, to five hours by snowmobile. Within a few years of their initial introduction, snowmobiles completely replaced travel by skis and reindeer sleds in herding reindeers. Unfortunately, the effect of the snowmobiles on the Lapps' reindeer was disastrous. The noise and the smell of the machines drove the reindeer into a near-wild state. The friendly relationships between the Lapps and their animals was disrupted by the high-speed machines. Frightened running by the reindeer

decreased the number of reindeer calves born each year. As a result, the average number of reindeer per household in Sevettigarvi dropped from fifty-two in presnowmobile days, to only twelve in 1971, a decade later. In fact, this average is misleading because about two-thirds of the Lapp households completely dropped out of reindeer raising as a result of the snowmobile; most could not find other work and were unemployed. On the other hand, one family in Sevettigarvi, who were relatively early to purchase a snowmobile, built up a large herd, and by 1971 owned one-third of all the reindeer in the community.

Not only did the frightened reindeer have fewer calves, but the precipitous drop in the number of reindeer also occurred because many of the animals were slaughtered for the sale of meat, in order to purchase the snowmobiles, gasoline for their operation, and spare parts and repairs. A new machine cost about $1,000, and gas and repairs typically cost about $425 per year. Despite this relatively high cost (for the Skolt Lapps, who lived on a subsistence basis), snowmobiles were considered a household necessity, and the motorized herding of reindeer was considered much more prestigious than herding by skis or reindeersleds. The snowmobile revolution pushed the Skolt Lapps into cash dependency, debt, and unemployment.

One might wonder why the Lapps, given their love for the reindeer and the disastrous effects on reindeer herding caused by snowmobiles, did not resist this technological innovation. The reason, Dr. Pelto (1973, p. 192) suggests, is because there was no point in the introduction and diffusion of snowmobiles when the Skolt Lapps could have studied and discussed the possible future outcomes of the technology, and decided on whether the innovation should proceed unchecked. Such an assessment of the technology's impact could have been made in the early 1960s, but it was not, in part because the Lapps were not technically able to anticipate the far-reaching consequences of the snowmobile. Further, Lapp society is very individualistic, and given the technology's advantages for the first adopters (who tended to be wealthier and younger than the average), complete adoption was impossible to prevent.

So today, the reindeer-centered culture of the Skolt Lapps has been severely disrupted. Most families are unemployed and depend upon the Finnish government for subsistence payments. The snowmobile revolution in the arctic led to disastrous consequences for the reindeer and for the Lapps who depended on them for their livelihood.

Since the anthropological study of the snowmobile revolution by Pertti Pelto, certain further technological developments have occurred in Lapland. During the summer months, some Lapps have begun using motorcycles to herd their reindeer. And certain of the affluent Lapps have even begun to use helicopters. An increasing number of reindeer that are slaughtered for meat have been found to have stomach ulcers.

A Model for Studying Consequences

We argue in this chapter that the consequences of innovation have generally been understudied in past diffusion research. Much past research has asked: "What variables are related to innovativeness?" While such inquiry has played a useful role in the past, future investigations need to ask: "What are the *effects* of adopting innovations?" Figure 11-1 contrasts these two research objectives, which are quite different.

Innovativeness, the main dependent variable in much past research, now becomes only a predictor of a more ultimate dependent variable, consequences of innovation. This new model seeks to explain consequences, a research goal that is closer to the objectives of most change agencies. They usually want to bring about desirable consequences among their clients, not simply the adoption of innovations per se.

An illustration of the use of the new model of consequences is provided by Mason and Halter (1968), who first determined variables related to innovativeness among Oregon farmers. Then they include innovativeness, along with other variables, to explain farm production levels, one type of desired consequence of the adoption of agricultural innovations. They predicted about 50 percent of the variance in farm production, and found that innovativeness made a unique contribution in raising yields. Inquiries such as this demonstrate an approach that could potentially provide quantifiable and predictive generalizations about consequences. But there are relatively few such quantitative investigations of the impact of innovations (we shall discuss several of them later in this chapter). Most diffusion research stopped with an analysis of the *decision* to adopt a new idea, ignoring how this choice was implemented into action, and to what consequences. So most diffusion research falls one step short of consequences (Goss, 1979).

Why Haven't Consequences Been Studied More?

When the last careful content analysis was made of all the diffusion publications then available (in 1968), only 38 of the nearly 1,500

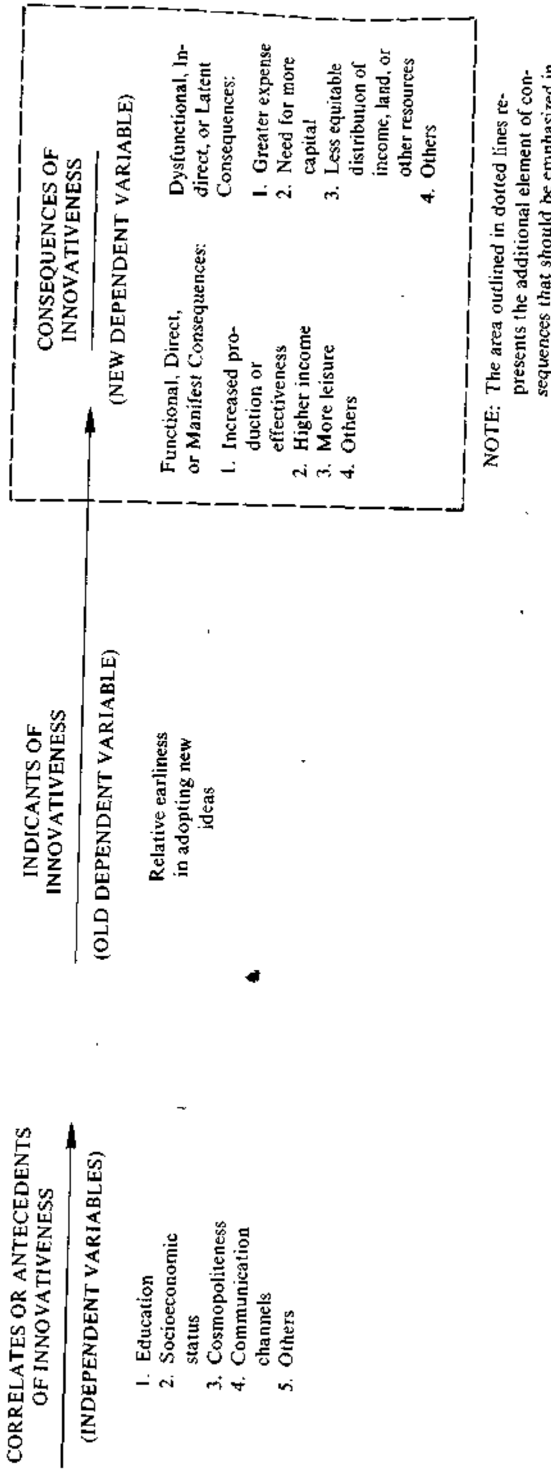

Figure 11-1. A new model for studying the consequences of innovation.

reports (less than 3 percent) dealt with the consequences of innovations. My reading of all diffusion publications as of the present writing indicates that this imbalance has not changed much since then.

Why are there so few studies of consequences? Three main reasons are:

1. *Change agencies, often the sponsors of diffusion research, overemphasize adoption per se, tacitly assuming that the consequences of innovation decisions will be positive.* Typically, diffusion researchers devote much attention to the antecedents of adoption, including socioeconomic and personal characteristics of the respondents and their communication behavior, for example. Change agencies assume that the innovation is needed by their clients, that its introduction will be desirable, and that adoption of the innovation represents "success." But we know that these pro-innovation assumptions are not always valid.

2. *Perhaps the usual survey research methods are inappropriate for the investigation of innovation consequences.* Extended observation over time can prove useful, or an in-depth case-study approach might produce more insights about consequences. The participant-observation technique used widely by anthropologists may be helpful, in that it does not depend so heavily upon the receivers' perceptions of an innovation's consequences.* Because diffusion researchers have been highly stereotypical in relying almost entirely upon survey methods of data gathering, they have ignored studying consequences, a type of inquiry for which the usual one-shot survey method is not very effective. But the anthropological approaches suffer in that they largely yield idiosyncratic, descriptive data from which generalization to other innovations and to other systems is difficult or impossible.

The study of consequences is complicated by the fact that they usually occur over extended periods of time. The study of an innovation's consequences cannot be accomplished simply by adding an additional question to a survey instrument, another one hundred respondents to the sample population, or another few days of data gathering in the field. Instead, a long-range research approach must be taken in which consequences are analyzed as they unfold over time. Otherwise, the consequences of an innovation can be neither properly assessed nor predicted.

A panel study (which is really a "double survey" in that the

* Perhaps it is significant that anthropologists, who have investigated consequences more than any other diffusion research tradition, have seldom used survey methods in their inquiries.

respondents are interviewed more than once) allows the same respondents to be interviewed both before and after an innovation is introduced and thus can yield desired information about consequences.* Firm data about consequences could also come from carefully conducted field experiments in which an innovation is introduced to a system on a pilot basis and its results evaluated under realistic conditions prior to its widespread diffusion and adoption. These studies over time, like the panel study and the pilot field experiment, can provide more quantifiable "firm" data about expected consequences. Such data can lead to generalizations about consequences, rather than mere description. And they are predictive to a future point in time, rather than being simply post-mortems of consequences that have already occurred. In fact, we draw upon several panel studies and field experiments in our discussion (below) of the equality consequences of innovations.

3. *Consequences are difficult to measure.* Individuals using an innovation are often not fully aware of all the consequences of their adoption. Therefore, any attempt to study consequences that rests only on respondents' reports may lead to incomplete and misleading conclusions.*

Judgments concerning consequences are almost unavoidably subjective and value laden, regardless of who makes them. Cultural norms, personal preferences, and biases are an integral part of the frame of reference of every observer of a social scene, in spite of efforts to be free of such prejudicial attitudes. To some degree every judge of the desirable or undesirable impacts of an innovation is influenced by his or her personal experiences, educational background, philosophical viewpoint, and the like. A researcher from one culture may find it particularly hard to make completely objective judgments of the desirability of an innovation in another country.

The concept of *cultural relativism* is the viewpoint that each culture should be judged in light of its own specific circumstances and needs. No culture is actually "best" in an absolute sense; each culture works out its own set of norms, values, beliefs, and attitudes that function most effectively for itself. Conditions in a particular country may therefore seem strange and unsuitable to a foreign observer, when many of these conditions result from centuries of experiment, trial and error, and evolution. Most are quite reasonable, given the

* Examples of such panel studies of consequences are Havens and Flinn (1975), Havens (1975), Shingi and Mody (1976), and Shingi et al (1981).

* This is one advantage of the observation method of data gathering, which does not depend so much (as the survey) upon the receivers' perception of consequences.

conditions in which they exist. For instance, many newcomers to India are puzzled by the millions of sacred cows that roam the countryside freely, while many people live under famine conditions. The foreigner is unlikely to understand that the Indian cattle provide manure for fuel, fertilizer, and housing construction, and thus may be a very positive element in India. So the holiness of cows in the Hindu religion may be functional, rather than just a cultural oddity.

The concept of cultural relativism has implications for the measurement of consequences. For whether data about the results of an innovation are gathered from clients, change agents, or scientific observers, the view by these observers of an externally introduced innovation is likely to be subjectively flavored by their own cultural beliefs. Consequences should be judged as to their functionality in terms of the users' culture, without imposing outsiders' normative beliefs about the needs of the client system. Such cultural relativism, however, is extremely difficult to accomplish.

A further problem in measuring the consequences of an innovation is that they are often confounded with other effects. For example, in assessing the results of an innovation like chemical fertilizer on crop yields, one cannot ignore the consequences caused by natural events like droughts or volcanic eruptions. This confounding is difficult or impossible to avoid completely, even with carefully conducted field experiments with before-and-after measurements and a control group. So one of the problems in measuring the consequences of innovations is that of untangling cause-and-effect relationships. Ideally, we should only measure the consequences that are exclusively the outcome of an innovation, the changes that would not have occurred if the innovation had not been introduced. But as we shall argue shortly, many important consequences are unanticipated and indirect; these effects of an innovation are very difficult to determine in a precise manner. For instance, the classification of unanticipated consequences rests on an investigator's ability to determine the original objectives for introducing an innovation in a system; such purposes may be partly concealed by subsequent rationalizations on the part of the members of the system (Goss, 1979).

Classifications of Consequences

One step toward an improved understanding of the consequences of innovations is to classify them into a taxonomy. Consequences are not

unidimensional; they can take many forms and are expressed in various ways. In this book we find it useful to analyze consequences according to three dimensions: (1) desirable versus undesirable, (2) direct versus indirect, and (3) anticipated versus unanticipated, although this is by no means the only way to classify the consequences of innovations.

Desirable Versus Undesirable Consequences

Desirable consequences are the functional effects of an innovation to an individual or to a social system. On the other hand, *undesirable consequences* are the dysfunctional effects of an innovation to an individual or to a social system. The degree to which an innovation is desirable or undesirable ultimately depends, of course, on how the innovation affects the members of the system. The determination of whether consequences are functional or dysfunctional depends on how the innovation affects the adopters. It is possible, of course, for an innovation to cause consequences for individuals other than its adopters. For instance, rejectors of a new idea may be affected because the innovation gives a boost to the other members of a system that adopt it, widening a socioeconomic gap over the rejectors. So consequences do not occur exclusively to those individuals or systems that decide to adopt an innovation. Often everyone in the system is touched by the consequences.

Certain innovations seem to have undesirable impacts for almost everyone in a social system. Our previous example of the snowmobile might provide such a case, although a few Lapps became very rich reindeer owners as a result of the innovation. But the ski-doo was disastrous for the Finnish Lapps in general. Every social system has certain qualities that should not be destroyed if the welfare of the system is to be maintained. These might include family bonds, respect for human life and property, maintenance of individual respect and dignity, and appreciation for others, including appreciation for contributions made by ancestors. Certain other sociocultural elements are more trivial and can be modified, discontinued, or supplanted with little impact, either positive or negative. And finally, every system has certain desired qualities like providing for individuals' basic needs, improving the quality of life, and so on, that are widely acknowledged as functional for individuals and for the system. An innovation that enhances one or more of these desiderata is certainly functional for the system. Nevertheless, we must recognize that it is difficult to avoid making value judgments as to the desirable versus undesirable consequences of an innovation for individuals and their social system.

An innovation may be functional for a system but not functional for certain individuals in the system. Consider the example of the adoption of "miracle" varieties of rice and wheat in India and other nations that led to what is called the "Green Revolution." These innovations provided higher crop yields and more income to the farmers who adopted. Yet the Green Revolution also led to fewer farmers, migration to urban slums, higher unemployment rates, and political instability. So although certain individuals profited from the adoption of the new seeds, they caused important but unequal conditions for the system. Are the consequences desirable or undesirable? The answer depends on whether one takes certain individuals or the entire system as the point of reference.

WINDFALL PROFITS

An innovation may be more functional for some individuals than for others; certain positive consequences may occur for certain members of a system at the expense of others. For instance, laggards are the last to adopt innovations; by the time they adopt a new idea, they are often forced to do so by economic pressures. By being the first in the field, innovators frequently secure a kind of economic gain called windfall profits. In a more general sense, windfall profits can be measured in social as well as economic terms. An example is the prestige that the innovator of a consumer product (like a new clothing fashion) may obtain by being the first to use the new idea.

Windfall profits are a special advantage earned by the first adopters of a new idea in a social system. Their unit costs are usually lowered and their additions to total production have little effect on the price of the product. But when all members of a social system adopt a new idea, total production or efficiency increases, and the price of the product or service often goes down. This offsets the advantage of lowered unit costs.

The innovator must take risks in order to earn windfall profits. All new ideas do not turn out successfully, and occasionally the innovator's fingers get burned. It is possible that adoption of a noneconomic or unsuccessful innovation could result in "windfall losses" for the first individuals to adopt. An example of windfall losses occurred in the diffusion of pocket calculators. The first model sold (in September 1971) measured three-by-five inches and cost $249;

this calculator was a "four-banger," as they are called in the industry, that could add, subtract, multiply, and divide. Within a year, by late 1972, the price of such a four-function calculator dropped to $100; in another year the price was only $50, and by 1981 a four-banger cost less than $10 (and the size shrunk to the thickness of a credit card). The precipitous decrease in the price of pocket calculators was due (1) to cheaper transistors (the most expensive component), and (2) high-volume production (in 1981 pocket calculators totaled $700 million annual sales and were the fourth largest-selling consumer product). So *later* adopters gained a windfall profit in this case.

Windfall profits are a relative type of gain that one individual in a social system receives and others do not. Windfall profits are a reward for innovativeness and a penalty for laggardness. We know that innovators are initially wealthier than laggards. Usually new ideas make the rich richer and the poor poorer, widening the socioeconomic gap between the earlier and later adopters of a new idea.

In order to illustrate the nature of windfall profits, data from the Iowa hybrid seed corn study by Gross (1942) were reanalyzed by Rogers (1962, p. 276). The innovators of this new idea, who adopted in the late 1920s, earned almost $2,500 more than the laggards, who adopted hybrid seed in 1940-1941. The innovators earned these windfall profits because of: (1) a higher market price for corn which lasted only until most farmers adopted hybrid seed and corn production was increased; (2) their larger corn acreages (for example, the innovators who adopted in 1927 average 124 acres of corn while the typical laggard who adopted in 1941 raised only 70 acres of corn); and (3) the greater number of years they received the higher yields from hybrid seed. Other illustrations of how an innovation's consequences often benefit certain individuals in a system more than others, thus widening socioeconomic gaps in a system, are provided later in this chapter.

THE ERRONEOUS ASSUMPTION OF SEPARABILITY

Most innovations cause both desirable and undesirable consequences. Understandably, individuals generally want to obtain the functional effects of an innovation and to avoid the dysfunctional effects. But this assumes that certain of the desired consequences from a technological innovation can be separated from the consequences that are not wanted. Such an assumption of separability usually involves desired advantages from a new technology such as increased effectiveness, efficiency, or convenience, versus such unwanted consequences as changes in social values and institutions.

An illustration is provided by the 1979 revolution against the Shah of Iran, led by the Ayatollah Khomeini. This political and religious movement made extensive use of such communication technology as long-distance, direct-dial telephone calls, through which the Ayatollah's daily messages were conveyed from his place of exile in France to his Iranian followers, who tape-recorded them and then clandestinely distributed them in the form of cassette tapes, and mimeographed and xeroxed sheets. One Iranian observed: "We are struggling against autocracy, for democracy, by means of xerocracy" (Tehranian, 1979). With the help of such communication technology, the Iranian revolutionaries were able to organize massive demonstrations in Tehran against the Shah, involving several million protesters on several occasions.

After the fall of the Shah, the famous Italian journalist Oriana Fallaci (1979) interviewed the Ayatollah and asked him why he used such harsh words when speaking of the West. He replied: "We got many bad things from the West, a lot of suffering, and now we have good reasons to fear the West, to keep our youth from getting too close to the West . . . where they become corrupted by alcohol, by the music that blocks out thought, by drugs, and uncovered women." But, the Ayatollah continued, "We are not afraid to use [such Western technologies as television, air conditioning, and the telephone], and we do. We are not afraid of your science and your technology" (Fallaci, 1979).

The Iranian leader here implies the assumption of separability of the desired effects of Western technology from the social values and institutions in which the technological innovations are embedded in Western nations. Many change agents make this assumption, and usually it turns out to be wrong. Earlier in this chapter, we discussed the desired advantages of the snowmobile among the Finnish Lapps such as faster transportation, which unfortunately brought with it the decline in reindeer raising and its accompanying consequences of widespread unemployment and other social problems.

We conclude with Generalization 11-1: *It is usually difficult or impossible to manage the effects of an innovation so as to separate the desirable from the undesirable consequences.*

The Old Order Amish in the United States exemplify a social system that has successfully maintained its distinctive culture for several hundred years. The Amish generally avoid adopting technological innovations like cars and tractors, electricity, and

household conveniences, because they understand that the social consequences of these innovations would lead to the breakdown of Amish society. So the Amish wisely take account of the principle of inseparability in managing technological consequences; they willingly forego the desired advantages of tractors and modern farm equipment (such as higher crop yields and larger incomes) in order to avoid the undesirable consequences of increased dependence on non-Amish businesses (such as farm machinery dealers), lessened farm labor requirements, and the pressure for larger-sized farms (Ericksen and others, 1980).

The Amish live in tight-knit communities in Pennsylvania, Ohio, Indiana, Iowa, and several other states. In these locales, the Amish have successfully and self-consciously striven to maintain their ideology of a belief in farming, high fertility, and a plain, "non-worldy" lifestyle. For example, the Amish speak a German dialect, do not send their children to public schools, believe in hard work, and try to produce everything that they consume. The public stereotype of the Amish is of bearded men, dressed in drab-colored, homemade clothes, riding in a horse-drawn buggy along the shoulder of a modern highway. The most noted Amish community is Lancaster County, Pennsylvania, where this religious sect has survived for over 200 years by following a general rule of not adopting innovations. The fertile soil allows the Amish to succeed financially on small-sized farms of about fifty acres, which they operate labor-intensively; their high fertility (the average family has more than seven children) provides the work force, so that mechanized equipment is not needed. In the face of recently skyrocketing land prices, however, Amish parents now are frequently unable to set up their children in farming, and when they enter urban occupations the young people often drop out of Amish society. So the Old Order Amish, who have coped by following an antiinnovation policy in the past, now face an uncertain future (Ericksen and others, 1980).

But their general adherence to the principle of inseparability has served them well. They forego most modern technological innovations in farming and household living because they fear the social consequences that would inevitably accompany them.

Direct Versus Indirect Consequences

Because of the intricate, often invisible web of interrelationships among the elements in a culture, a change in one part of a system often

initiates a chain reaction of indirect consequences stemming from the direct consequences of an innovation. *Direct consequences* are the changes to an individual or a social system that occur in immediate response to an innovation. *Indirect consequences* are the changes to an individual or a social system that occur as a result of the direct consequences of an innovation. One might think of the adoption of an innovation as an independent variable that leads to certain direct consequences (these are a collection of dependent variables). Then, in a more complex sense, the effects of the independent variables (adoption of an innovation) are mediated through the intervening variables of the direct effects, so as to cause indirect consequences, which are now the dependent variables (Goss, 1979).

An illustration of this framework for understanding the direct and indirect consequences of an innovation is diagrammed in Figure 11-2, based on an anthropological study of the adoption of wet rice farming by a tribe in Madagascar (Linton and Kardiner, 1952, pp. 222-231). The tribe had been a nomadic group that cultivated rice by dry-land methods. After each harvest they would move to a different location. Many social changes resulted in the tribe's culture after the adoption of wet-land rice farming. A pattern of land ownership developed, social status differences appeared, the nuclear family replaced the extended clan, and tribal government changed. The consequences of the technological innovation were both direct and far-reaching, in that several generations of consequences from wet rice growing spread from the more direct results.

A contemporary example of direct and indirect consequences is provided by the use of semiconductors (that is, computers on a tiny silicon chip) in household appliances, automobiles, and in new communication technology such as home computers. The direct results of the semiconductors are to conserve energy, such as in "smart" appliances like hot water heaters that only provide heated water when it will be needed, and to prevent traffic accidents through a brake override system that is activated when an auto begins to skid. The home computer, thanks to the semiconductors that it contains, allows an individual to tap data banks containing information about plane schedules, the weather, and financial news, and to conduct one's banking and grocery purchasing.*

*The author visited a bank in the Federal Republic of Germany that calls itself the world's first completely electronic bank. There are no bank buildings, just computer terminals and screens, on which a customer makes financial transactions. The 60,000 customer accounts are managed by just 40 employees, plus one large computer. Because of its low overhead costs, this German bank pays 1 percent higher interest

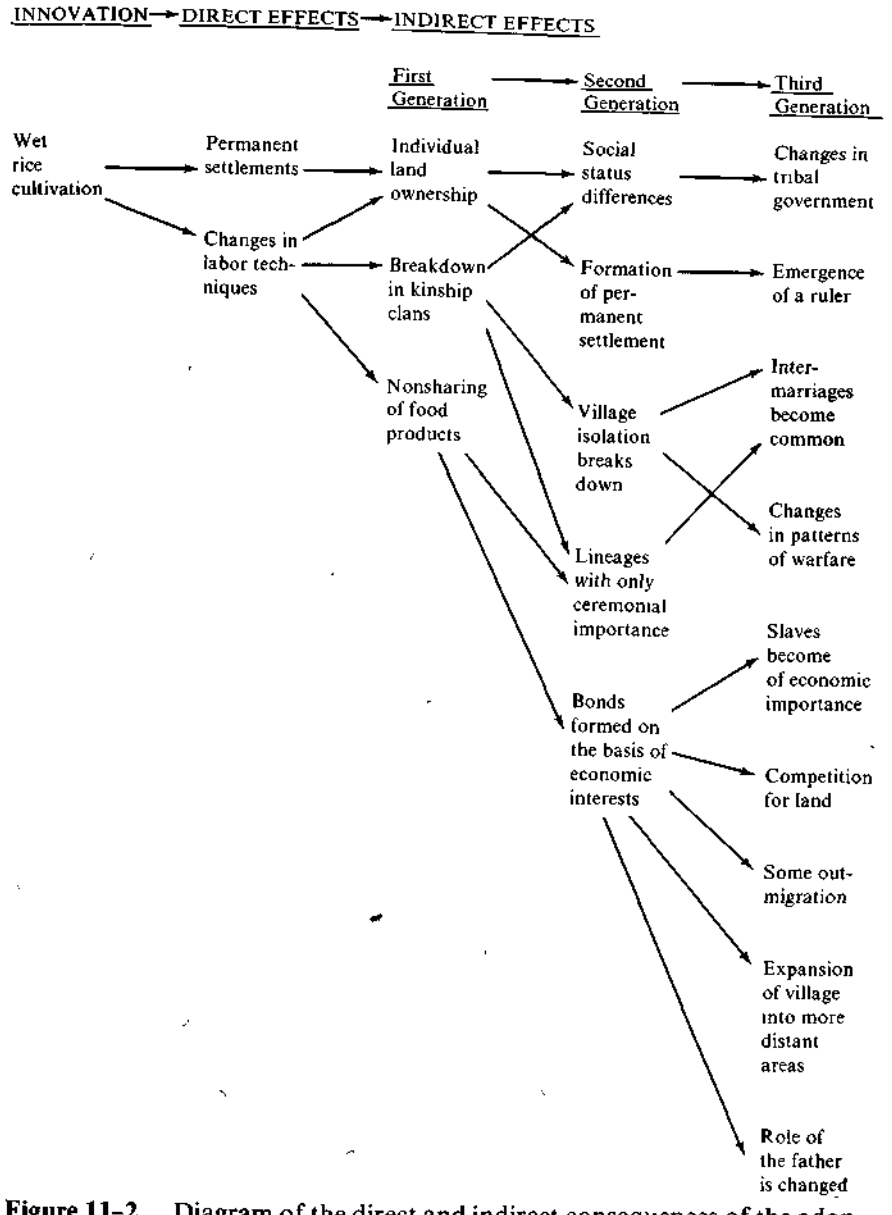

Figure 11-2. Diagram of the direct and indirect consequences of the adoption of wet rice growing in Madagascar.

Source: Based on results provided by Linton and Kardiner (1952, pp. 222-231), used by permission of Columbia University Press.

Each of these direct effects of semiconductors is likely to be accompanied by many indirect consequences. For example, the convenience of at-home banking and shopping may also lead to the possible invasion of household privacy; what if one's bank overdrafts were made known to one's employer? Further, some individuals fear that once computer-based data banks exist, the data they contain, such as one's automobile speeding violations, college grades, and the consumer products that one has purchased, might be made available to potential employers and/or to other authorities. Certainly, the indirect consequences of such a beneficial innovation as small, low-priced computers (that are made possible by semiconductors) may turn out to be problematic, including both desirable and undesirable consequences to various individuals and social systems. The "electronics revolution" made possible by semiconductors in modern society may lead to numerous generations of consequences, as did wet rice farming in Madagascar.

The indirect consequences of an innovation are often especially difficult to plan for, and manage, as they are often unanticipated.

Anticipated Versus Unanticipated Consequences

Anticipated consequences are changes due to an innovation that are recognized and intended by the members of a social system. An example of such a manifest consequence is the snowmobiles' advantage to the Lapps of providing rapid transportation. They could not, however, anticipate such latent consequences of this innovation as its disastrous effects on reindeer raising. Although they are less discernible to observers, the "subsurface" consequences of an innovation may be just as important as the anticipated consequences. *Unanticipated consequences* are changes due to an innovation that are neither intended nor recognized by the members of a social system. The disintegration of respect for their elders among the Yir Yoront, in the case study that follows, is an example of an unanticipated consequence of the adoption of steel axes. This change in familiar relations was of tremendous importance to the tribe, even though such a consequence was not readily apparent when steel axes were first introduced by well-meaning missionaries.

Almost no innovation comes with no strings attached. The more

rates than other banks. But the international bankers' association and the bank employees' labor union are concerned about the effect of electronic banking on future unemployment rates.

important and the more technologically advanced an innovation is (and therefore the more the change agent desires its rapid adoption), the more likely its introduction is to produce many consequences—some of them anticipated, but others unintended and latent. A system is like a bowl of marbles: move any one of its elements and the positions of all the others are also changed.

This is often not fully understood by the adopters of an innovation, and may not be comprehended by the change agents who introduce a new idea in a system. Unanticipated consequences represent a lack of understanding of how an innovation functions and of the internal and external forces at work in a social system (Goss, 1979). In Chapter 1 we argued that awareness of a new idea creates uncertainty about how the innovation will actually function for an individual or other adopting unit in a system. This uncertainty motivates active information seeking about the innovation, especially through interpersonal peer networks. Individuals particularly seek *innovation-evaluation information,* defined as the reduction in uncertainty about an innovation's expected consequences. Such uncertainty can be decreased to the point where an individual feels well informed enough to adopt the new idea. But uncertainty about an innovation's consequences can never be completely removed.

The adopter is often able to obtain adequate information from peers about the desirable, direct, and anticipated consequences of an innovation. But the unanticipated consequences are by definition unknown by individuals at their time of adoption. Such unforeseen impacts of a new idea represent a type of innovation-evaluation information that cannot be obtained by an individual from other members of his or her system. Often professional change agents cannot know the unanticipated consequences until after widespread adoption has occurred (if then), as we see in the following case of the steel ax, introduced by missionaries to an Australian tribe.

We conclude this discussion of the three classifications of consequences with Generalization 11-2: *The undesirable, indirect, and unanticipated consequences of innovations usually go together, as do the desirable, direct, and anticipated consequences.*

Steel Axes for Stone-Age Aborigines*

The consequences of the adoption of steel axes by a tribe of Australian aborigines vividly illustrates the need for consideration of the undesirable,

* Adapted from Sharp (1952, pp. 69-92), and used by permission.

indirect, and unanticipated consequences of an innovation. The tribe was the Yir Yoront, who traveled in small nomadic groups over a vast territory in search of game and other food. The central tool in their culture was the stone ax, which the Yir Yoront found indispensable in producing food, constructing shelters, and heating their homes. It is hard to imagine a more complete revolution than that precipitated by the adoption of the steel ax as a replacement for the stone ax.

The method of study used by Sharp (1952) to investigate the Yir Yoront is that of participant observation, in which a scientist studies a culture by taking part in its everyday activities. In the 1930s an American anthropologist was able to live with the Yir Yoront for thirteen months without seeing another outsider. Because of their isolation, the tribe was relatively unaffected by Western civilization until the establishment of a nearby missionary post in recent years. The missionaires distributed many steel axes among the Yir Yoront as gifts and as payment for work performed.

Before the days of the steel ax, the stone ax was a symbol of masculinity and of respect for elders. Only men owned the stone axes, but women and children were the principal users of these tools. The axes were borrowed from fathers, husbands, or uncles according to a system of social relationship prescribed by custom. The Yir Yoront obtained their stone ax heads in exchange for spears through bartering with other tribes, a process that took place as part of elaborate rituals at seasonal fiestas.

When the missionaries distributed the steel axes to the Yir Yoront, they hoped that a rapid improvement in living conditions would result. There was no important resistance to the shift from stone to steel axes, because the tribe was accustomed to securing their tools through trade. Steel axes were more efficient for most tasks, and the stone axes rapidly disappeared among the Yir Yoront.

But the steel ax contributed little to social progress; to the disappointment of the missionaries, the Yir Yoront used their new-found leisure time for sleep, "an act they had thoroughly mastered." The missionaries distributed the steel axes to men, women, and children alike. In fact, the young men were more likely to adopt the new tools than were the elders, who maintained a greater distrust for the missionaries. The result was a disruption of status relations among the Yir Yoront and a revolutionary confusion of age and sex roles. Elders, once highly respected, now became dependent upon women and younger men, and were often forced to borrow steel axes from these social inferiors.

The trading rituals of the tribe also became disorganized. Friendship ties among traders broke down, and interest declined in the annual fiestas, where the barter of stone axes for spears had formerly taken place. The religious system and social organization of the Yir Yoront became disorganized as a result of the tribe's inability to adjust to the innovation. The men began the practice of prostituting their daughters and wives in exchange for use of someone else's steel ax.

THE FORM, FUNCTION, AND MEANING OF AN INNOVATION. We see, then, that many of the consequences of the innovation among the Yir Yoront were undesirable, indirect, and unanticipated; these three types of consequences often go together, just as desirable, direct, and anticipated consequences are often associated. The case of the steel ax also illustrates a common error made by change agents in regard to an innovation's consequences. They are able to anticipate the form and function of an innovation, but not its meaning for potential adopters. What do we mean by the form, function, and meaning of an innovation?

1. *Form* is the directly observable physical appearance and substance of an innovation. Both the missionaries and the Yir Yoront recognized the form of the new tool, perhaps in part because of its similarity to the appearance of the stone ax.

2. *Function* is the contribution made by the innovation to the way of life of members of a social system. The tribe immediately perceived the steel ax as a cutting tool, to be used in much the same way as the stone ax had been.

3. *Meaning* is the subjective and frequently unconscious perception of the innovation by members of a social system. "Because of its subjective nature, meaning is much less susceptible to diffusion than either form or [function]. ... A receiving culture attaches new meanings to the borrowed elements of complexes, and these may have little relation to the meanings which the same elements carried in their original setting" (Linton, 1936).*

What mistakes did the missionaries make in the introduction of the steel ax? The change agents seem to have understood the form and function of the steel ax. They believed the Yir Yoront would use the new tool in much the same way as they had the stone ax, such as for cutting brush. But the missionaries made an egregious error in not predicting the meaning of the new idea to the Yir Yoront. They did not anticipate that the steel ax would lead to more hours of sleep, prostitution, and a breakdown of social relationships and customs. Change agents frequently do not sense or understand the social meaning of the innovations that they introduce, especially the negative consequences that accrue when an apparently desirable innovation is used under different conditions. Change agents are especially likely to make this mistake if they do not empathize completely with the innovation's users, especially when the change agents are heterophilous with their clients.

So we conclude with Generalization 11-3: *Change agents can more easily anticipate the form and function of an innovation for their clients than its meaning.*

ACHIEVING A DYNAMIC EQUILIBRIUM. Perhaps the missionaries introduced too many steel axes too rapidly. What rate of change will allow a

* This notion is basically similar to the concept of *reinterpretation* defined as the process that occurs when the receivers use an innovation for purposes different from those conceived of when it was invented or diffused to them. Reinterpretation is a type of re-invention.

system to achieve the benefits of an innovation, and yet not produce disequilibrium in a social system?

Change agents need to think of three types of equilibrium in a system.

1. *Stable equilibrium* occurs when there is almost no change in the structure or functioning of a social system. Perhaps a completely isolated and traditional system in which the rate of change is almost zero, provides an example of stable equilibrium.

2. *Dynamic equilibrium* occurs when the rate of change in a social system is commensurate with the system's ability to cope with it. Change occurs in a system in dynamic equilibrium, but it occurs at a rate that allows the system to adapt to it.

3. *Disequilibrium* occurs when the rate of change is too rapid to permit the social system to adjust. An analogy is a traffic circle with one too many cars in it; all movement stops. The social disorganization that accompanies disequilibrium marks it as a painful and inefficient way for change to occur in a system.

The long-range goal of most change agents is to produce a condition of dynamic equilibrium in the client system. Innovations are introduced into the system at a deliberate rate that allows for careful balancing of the system's ability to adjust to the changes. This delicate gauging of the optimum rate of change in a system is extremely difficult. It seems that the missionaries among the Yir Yoront misjudged the rate at which the aborigines' system could absorb the consequences of the steel ax.

TO WHOM AN INNOVATION IS INTRODUCED. One of the specific mistakes made by the missionaries was in to whom they introduced the innovation. Unaware of the cultural emphasis on respect for elder males among the Yir Yoront, the change agents gave steel axes to women, children, and young men indiscriminately. In general, one of the ways in which change agents shape the consequences of an innovation is in whom they work with most closely. If a change agent were to contact the poorer and less-educated individuals in a social system, rather than the socioeconomic elites (as is usually the case for most change agents), the benefits from the innovations that are so introduced would be more equal. Usually, however, change agents have most contact with the more-educated, higher-status individuals in a system, and thus tend to widen socioeconomic gaps through the innovations that they introduce.

This matter of to whom innovations are introduced brings us to the issue of equality.

Equality in the Consequences of Innovations

In addition to the desirable-undesirable, direct-indirect, and anticipated-unanticipated aspects of the consequences of innovation, one

might classify consequences as to whether they increase or decrease equality among the members of a social system. Note that here we are mainly talking about the consequences of an innovation at the system level (that is, whether some resource such as income or status is distributed more or less equally), rather than at the individual level.

As we have shown previously (especially in Chapters 7 and 9), diffusion generally causes wider socioeconomic gaps in an audience (that is, less equality) because:

1. Earlier adopters, especially innovators and early adopters, have favorable attitudes toward new ideas and are more likely to search actively for innovations. They also possess the available resources to adopt higher-cost innovations, while later adopters often do not.
2. Professional change agents tend to concentrate their client contacts on innovators and early adopters in hopes that the opinion leaders among these earlier adopting categories will then pass along the new ideas they have learned to their followers in a kind of "trickle-down" process. But in Chapter 8 we showed that most interpersonal network links connect individuals who are alike or similar in adopter category and socioeconomic status. So innovations generally "trickle across" rather than "trickle down" in the interpersonal communication structure of a social system.
3. By adopting innovations relatively sooner than others in their system, innovators and early adopters achieve windfall profits, thereby tending to widen the socioeconomic gap between these earlier adopting categories versus laggards. Thus the earlier adopters get richer, and the later adopters' economic profit is comparatively smaller.

So the diffusion of innovations, as this process generally happens, tends to decrease the degree of equality in a social system. But this tendency toward gap widening need not occur, if special strategies are followed to narrow gaps, as several recent researches show (to be reviewed shortly).

The Issue of Equality in Development Programs

The importance of the issue of equality in the distribution of an innovation's consequences began to be realized in the 1970s. Until that time, most diffusion programs simply ignored the equality issue, generally trusting in the "trickle-down theory" to cancel out the gap-widening tendencies of innovation diffusion in the long run. In fact,

most diffusion agencies, and the majority of diffusion investigations, paid little attention to the equality issue in the past. For instance, my 1971 book on diffusion (Rogers with Shoemaker, 1971) scarcely mentions the problem of unequal consequences of innovations. Most diffusion researchers were aware of this problem in the 1950s and 1960s, but we did not know what to do about it. We did not have a research approach that enabled us to analyze the equality/inequality consequences of diffusion, nor were funding sources encouraging research on this issue. Perhaps one reason explaining the long neglect of equality was the pro-innovation bias of diffusion researchers and of change agencies.

But beginning in the early 1970s, development programs in developing nations began to become much more conscious of the equality issue. This change in thinking happened as one part of the passing of the dominant paradigm of development (Rogers, 1976); until about 1970, the main index of development progress was the rate of annual increase in gross national product (GNP, the total annual income of a country). A yearly increase of 5 or 10 percent in GNP, as occurred in some countries such as Mexico, South Korea, and Taiwan, was defined as very successful development; most nations achieved a much lower rate of GNP increase.

But questions began to be asked in the early 1970s as to whether development really consisted entirely, or even mainly, of the rate of economic growth. For example, if the higher average income in a nation was spent mainly in consuming more alcohol, was that really development? And what if a nation increased its GNP by 8 percent per year, but almost all of this increase went into the hands of the already wealthy, leaving the majority of a nation's population as poor as before?

Such troublesome questions led to an emphasis upon equality in the emerging alternatives to the dominant paradigm of development after 1970. Instead of following a path toward industrialization and urbanization, involving the importation of capital-intensive technology such as steel plants and hydroelectric plants, nations began to make their villagers and urban poor the priority audience for development programs. Governments generally sought to close socioeconomic gaps by bringing up the lagging sectors and helping the weaker segments of their population. Instead of measuring development achievements solely in terms of their GNP, national planners began to think of greater socioeconomic equality as a goal for development, and to try to measure such noneconomic indicators of development as

improvement in the quality of life. In fact, *development* began to be defined as a widely participatory process of social change in a society, intended to bring about social and material advancement (including greater equality, freedom, and other valued qualities) for the majority of the people through their gaining greater control over their environment (Rogers, 1976).

But certainly the major change in thinking about development, beginning in the 1970s, was the new emphasis upon equality in the distribution of consequences of innovations. The new attention to equality was not confined to diffusion programs that were part of development activities in developing nations; a similar realization that equality was a crucial second dimension in the hoped-for effects of a diffusion program also occurred in developed nations like the United States during the 1970s. Equality, it seemed, was an issue whose time had come.

In our previous example of the impact of the snowmobile among the Skolt Lapps, we encountered an illustration of the two dimensions of consequences: (1) the first dimension of helping everyone travel more rapidly (this is achieving a higher average *level* of "Good," some widely desired objective or desideratum), and (2) the second dimension of the *unequal distribution* of a "Good" (the tendency for reindeer ownership to become concentrated in the hands of just a few Lapps). Figure 11-3 depicts these two dimensions of consequences; in the first situation, the average level of Good in a system increases as a result of the innovation, but the distribution remains equal. In the second situation shown, however, the average level of Good again increases, but the Good also becomes more concentrated in the hands of the socioeconomic elite as a consequence of the innovation; so the degree of equality in the system has decreased because of the innovation.

When diffusion scholars and change agents began to distinguish between (1) the level of Good, and (2) the equality of distribution of Good, as consequences of diffusion activities, the next logical step was to begin investigating the gap-widening and gap-narrowing impacts of diffusion.

The Communication Effects Gap and the Consequences of Diffusion

Most past communication research, including most diffusion studies, attempted to determine what effects a particular source, channel,

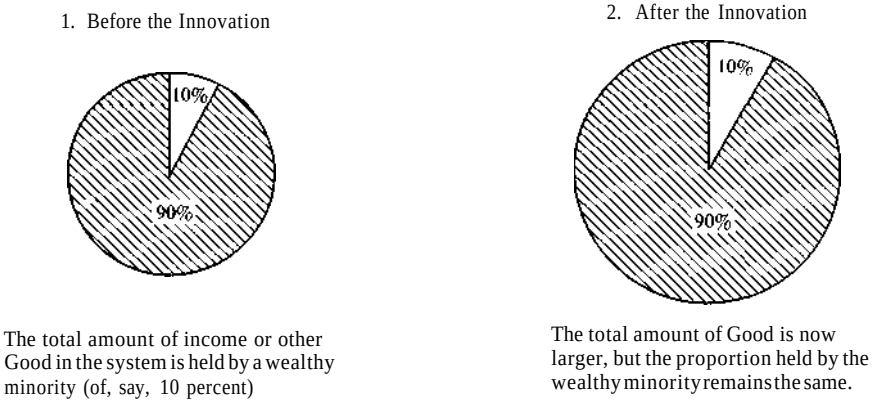

Figure 11-3. The two dimensions of consequences of an innovation in a system: Level of Good and equality.

message, or combination of such elements has on an audience. This research on the first dimension of communication effects mainly pursues the question: "What are the effects of a communication activity?" Effects are indexed mainly as the average change in the knowledge, attitudes, or overt behavior of a set of individuals.

The nature of research on the second dimension of communication effects is quite different. Here one asks: "Has the communication activity had a greater, or different, effect on certain individuals, rather than others?" Here the communication scholar seeks to ascer-

tain the *equality* of effects of communication, not just how much effect occurred *on the average* (or in the aggregate).

About the time that diffusion researchers began to turn to this second dimension, dealing with the equality issue, Tichenor et al (1970) proposed a useful research paradigm for studying gaps, implying that data should be gathered at two or more points in time, both before and after a communication activity. The measure of effects should be not just the average amount of behavior change in the audience (the first dimension), but whether gaps in socioeconomic status and/or in knowledge of information increased or decreased (this is the second dimension of effects). In essence, Tichenor et al (1970) suggested that we should look at who in an audience was affected most, and who least. Figures 11-4a and 11-4b depict this research approach to investigating the equality dimension of communication effects, a research paradigm that was found to be useful by diffusion scholars studying the equality of consequences of innovation.

One of the main implications of the communication effects gap paradigm, inspired by Tichenor et al (1970) and carried forward in studies by McNelly and Molina (1972), Katzman (1974), and Cook et al (1975), was to look *within* an audience to determine whether certain segments were more affected than other segments by a communication intervention. This analytic approach to looking also for differential effects, rather than just for average effects or aggregate effects on the entire audience, took communication scholars in the direction of focusing upon equality issues in the effects of communication. Equality of effects became the second dimension of communication effects research (Figure 11-4b).

Diffusion scholars thus began to analyze their data in order to investigate the degree to which a diffusion program widened or narrowed gaps among the members of a social system. The categorization of the total audience into two or more segments ("ups" and "downs") might be on the basis of socioeconomic status (for example, larger versus smaller farmers in a village), adopter category (for instance, earlier adopters versus later adopters), or the level of information possessed (the information-rich versus the information-poor). Almost no matter how the "ups" and downs" were classified,* certain regularities about equality in the consequences of diffusion were found.

* And, of course, it is not necessary to dichotomize the members of an audience as "ups" and "downs"; one could also have three or more categories, classified on the basis of some variable.

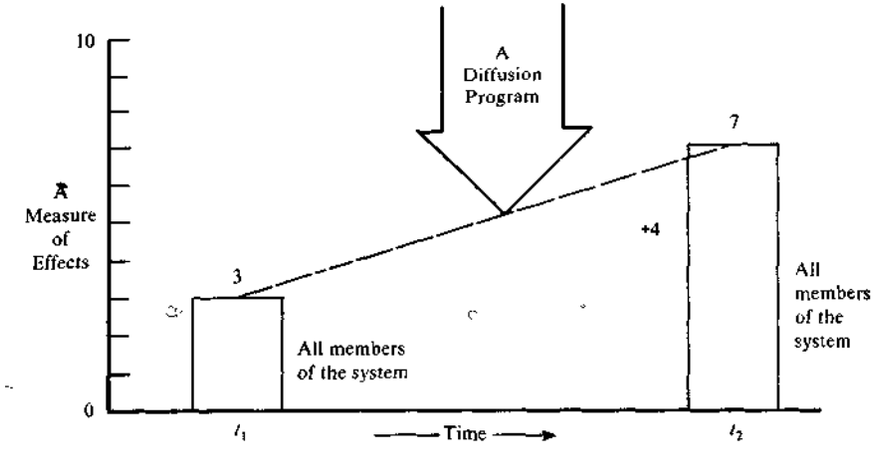

Figure ll-4a. The first dimension of communication effects (for all members of the system) is an average increase of four units, measured as the difference from t_1 to t_2.

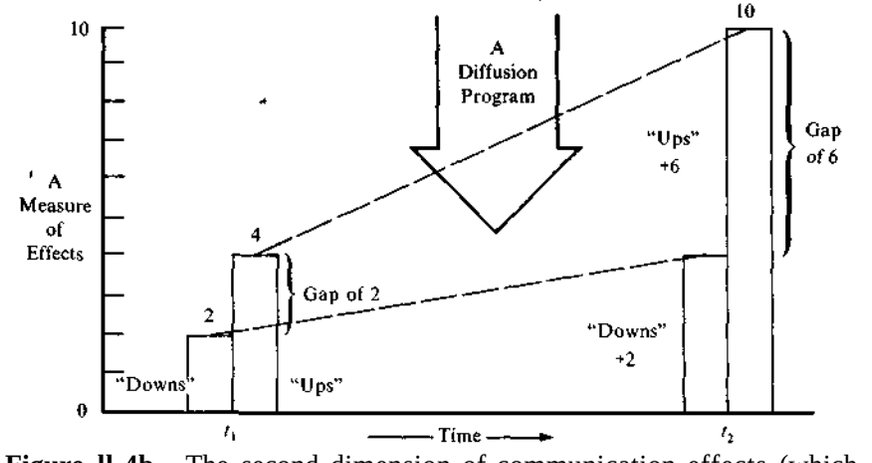

Figure ll-4b. The second dimension of communication effects (which analyzes effects separately for "downs" and "ups") indicates that the effects gap is widened by the diffusion program.

Note that the "downs" are *absolutely* better off as a result of the diffusion program (+ 2), but *relatively* worse off (as the "ups" gained +6). So the rich get richer (informationally) and the poor get less poor.

Gap-Widening Consequences of the Adoption of Innovations

Out of the several investigations that implicitly or explicitly followed the effects gap paradigm, we draw Generalization 11-4: *The consequences of the adoption of innovations usually tend to widen the socioeconomic gap between the earlier and later adopting categories in a system.* A second, related conclusion, Generalization 11-5, is also suggested by this research: *The consequences of the adoption of innovations usually tend to widen the socioeconomic gap between the audience segments previously high and low in socioeconomic status.*

Now we take up several of these researches to illustrate the two generalizations stated above. In one investigation, Havens and Flinn (1975) examined the consequences of two new coffee varieties among Colombian farmers over the eight-year period from 1963 to 1970. Of their original sample of fifty-six coffee growers, seventeen adopted the new varieties, which considerably increased their yields; it was important to adopt chemical fertilizers and weedicides along with the new coffee varieties in order to achieve these high yields. As a result of adopting this package of innovations, the seventeen adopters raised their net income from 6,700 pesos in 1963 to 21,000 pesos in 1970, an increase of 14,300 pesos (213 percent). The thirty-nine nonadopting coffee farmers (who did not use the new varieties) raised their net income from 4,500 pesos to 12,000 pesos, only an increase of 7,500 (166 percent). So one effect of the coffee variety innovations was to widen the income gap between the adopters and nonadopters from 2,200 pesos in 1963 to 9,000 pesos in 1970. The improved coffees caused much greater income inequality among the Colombian farmers, much as Figure 11-4b depicted.

How much of this increased inequality among the Colombian coffee growers was due to the adoption of the new coffee varieties, and how much of it was due to other factors, such as the initially larger farms, higher education, and other characteristics of the adopters? Havens and Flinn (1975) show that most of the increased income inequality was due to the introduction of the new coffees. For example, they computed the net income per acre of coffee grown, thus removing the effect of the larger-sized farms of the adopters. The adopters and nonadopters both began at about the same level of income per acre in 1963: 290 pesos per acre and 222 pesos per acre, respectively. But by 1970, when the adopters were securing the higher yields that

resulted from growing the new varieties, their income per acre shot up to 1,642 pesos per acre (an increase of 1,352 pesos), while the nonadopters' income per acre rose to only 632 pesos (an increase of only 415 pesos). Much of the increased income inequality between the adopters and nonadopters was, thus, due to the introduction of the coffee variety innovations.

What did the adopters do with their higher income? Some bought larger farms, with some of the land coming from the nonadopters. In 1963, the adopters averaged farms of 18.9 acres and the nonadopters 8.0 acres; by 1970, the adopters had increased their farms to 33 acres, while the nonadopters' farms shrank to an average size of 6.4 acres.* In addition, eleven of the nonadopters dropped out of farming, and either became day laborers or else migrated to the city; presumably, their farms were purchased by the adopters.

If adoption of the new coffee varieties were to have such important consequences, why didn't the thirty-nine nonadopters also start growing the new varieties? Havens and Flinn (1975) correlated various independent variables (such as age, education, trips to cities, farm size, and the like) with adoption/nonadoption. Economic variables such as income and farm size were the best predictors of adoption, along with the use of credit. Adopting a new coffee variety is a major decision in Colombia because three years are required for the new trees to come to production; many farmers need credit to tide them over this period before their investment in the new variety begins to pay off. The smaller *campesinos,* who did not have much land to put up as collateral, were generally unable to borrow funds to enable them to adopt the new coffee varieties, and they therefore lost the potential advantage of the higher yields and farm incomes that they could have achieved by adopting the new coffee varieties. So the unavailability of credit to the smaller farmers was a key factor in preventing them from adopting the innovations.

This vicious circle explains, in large part, how adoption of the coffee variety innovations widened the socioeconomic gaps (1) between

* One index of the equality of the distribution of a Good in a social system is the Gini-ratio, which expresses the relative degree of concentration of a resource in a few or in many hands (Allison, 1978). When the Gini-ratio is zero, each member of the system has an equal share of the Good. When it is 1.0, one member possesses all of the Good. Havens and Flinn (1975) found that the Gini-ratio for land concentration was .859 in 1963, and .706 in 1971; in other words, land ownership became less equally distributed and more concentrated in fewer hands.

the adopters and nonadopters, and (2) between those individuals originally high and low in socioeconomic status. The effect of the innovation was like a huge lever, prying wider the gap between the rich and the poor.*

Several other investigations follow a similar design to that of Havens and Flinn (1975), by measuring the equality consequences of innovations in a system at two or more points in time (thus following the research approach depicted in Figure 11-4). The results of these other investigations provide less definitive evidence in support of Generalizations 11-4 and 11-5. Shingi et al (1981) interviewed 228 Indian farmers in 1967 and again in 1973. They found increased inequality in gross agricultural production between (1) the laggards (defined as the eighty farmers who had not adopted any of a list of ten agricultural innovations in 1967), and (2) nonlaggards. But the main reason for slipping behind in farm production did not seem to be the laggards' non-adoption of innovations; in fact, the laggards adopted several of the agricultural innovations from 1967 to 1973, especially chemical fertilizer. Shingi et al (1981) point out that their respondents in Western India had endured a major drought from 1970 to 1973, and this climatic perturbation may have affected the distribution of the socioeconomic consequences of the innovations. Further, the ten innovations of study were not particularly capital intensive, and so the laggards were not blocked from adopting them by such economic factors as the availability of credit.

In another study performed in India, Galloway (1974) reanalyzed data originally gathered by Roy et al (1968a) from several hundred Indian farmers in 1964, 1966, and 1967. Early in this period, radio forums (small groups to discuss programs about innovations) and literacy/reading classes were organized among the respondents. Galloway (1974) found that gaps between higher- and lower-status farmers increased with the adoption of agricultural, health, and family-planning innovations, but that gaps in knowledge of these innovations actually narrowed (perhaps because special efforts were made to attract the lower-status villagers to participate in the radio forums and literacy/reading groups). So widening gaps may not be inevitable, a point to which we return shortly.

* As we discussed in Chapter 2, Hightower (1972) has charged the agricultural extension services in the United States with similar consequences of widening socioeconomic gaps among American farmers through the introduction of agricultural innovations, with small farmers being driven out of farming and forced to migrate to cities.

Social Structure and the Equality of Consequences

The general picture that may be emerging from the various investigations of the equality versus inequality consequences of innovations is that *how* an innovation is introduced, whether it is high-cost or not, and so forth, determines, in part, the degree to which it causes unequal consequences. Some of the best evidence for this contingency viewpoint comes from an investigation of the impact of adopting irrigation wells by villagers in Bangladesh and in Pakistan (Gotsch, 1972). In each country, an irrigation well cost about the same amount and was able to provide water for fifty to eighty acres of farmland. The introduction of Green Revolution wheat and rice varieties created a need for irrigation in both nations. But the equality of the consequences for what was essentially an identical innovation were quite different in Pakistan from those in Bangladesh, mainly because of the different social organisation that accompanied the new technology.

In Pakistan, 70 percent of the irrigation wells were purchased by farmers with twenty-five acres or more (considered to be very large-si/ed farms); only 4 percent of the villagers with farms of less than thirteen acres adopted. When the irrigation water was accompanied by the use of fertilizers and other agricultural chemicals, a fanner typically could expect to increase his net farm income by about 45 percent. So the irrigation wells in Pakistan made the rich richer. And the poor farmers became *relatively* poorer.

But in Bangladesh, average farm size was only one or two acres, and there were few large landowners. Less than 1 percent of the villagers had farms large enough to justify their private ownership of an irrigation well. So in Bangladesh, village cooperatives typically purchased a well, and provided irrigation water to everyone who belonged to the co-op. Farm incomes were approximately doubled because farmers could raise a winter crop of rice during the season when rainfall was scarce. In Bangladesh, the rate of adoption of the wells was slower than in Pakistan because the innovation decision was collective rather than individual-optional in nature. But the consequences of the innovation were distributed much more equally than they were in Pakistan, where an initially high degree of social stratification led to a concentration of the wells' impact among the rich fanners.

Gotsch (1972) concluded his analysis of the consequences of it riga-Lion wells by noting that the social structure in which the innovation was introduced in Bangladesh and Pakistan, rather than the innova-

tion itself, determined the distribution of its socioeconomic impact.* This investigation, along with certain of the consequences studies previously cited, such as Havens and Flinn (1975), suggests Generalization 11-6: *A system's social structure partly determines the equality versus inequality of an innovation's consequences.* When a system's structure is already very inequal, it is likely that when an innovation is introduced (especially if it is a relatively high-cost innovation), the consequences will lead to even greater inequality in the form of wider socioeconomic gaps.

The irrigation consequences study in Bangladesh and Pakistan illustrates, as does the Colombia coffee study, that an innovation's adoption and its impact are related to characteristics of the social system, as well as to variables at the individual level of analysis. The fact that village co-ops already existed in Bangladesh when irrigation wells were introduced, and that small coffee growers in Colombia could not obtain credit to adopt the new coffee varieties, largely determined who adopted and who could not. Note that the determining factors were mainly at the system level (although their impact occurred through individuals' actions). Why didn't the smaller farmers in Pakistan and Colombia adopt the innovations? The answer in these cases seems mainly to be one of system-blame, not individual-blame (Chapter 3).

Further, social structural factors are not always static barriers or facilitators of the adoption of innovations and their consequences. Significantly, a rural development agency in Bangladesh had organized the village cooperatives during the 1960s, just prior to the introduction of irrigation wells, for exactly the purpose that they served: to enable smaller farmers, through banding together, to adopt relatively high-cost innovations such as tractors and irrigation wells. In a parallel example, a government change agency in South Korea organized village women into mothers' clubs, thus forming communication networks for the diffusion of family-planning innovations and also creating a social organization for adopting and implementing village development projects (Rogers and Kincaid, 1981). But in both of these illustrations, the social structure put certain constraints on how far the change agents could go in changing the village social structure.

* As Karl Marx (1906, p. 468) observed: "It took both time and experience before the work people learned to distinguish between machinery and its employment by capital and to direct their attacks not against the material instruments of production but against the mode in which they were used."

Nevertheless, social structural variables are not a completely rigid barrier to greater equality in the consequences of innovations. Change agents can often modify the social structure in certain ways, at least up to a point.

Strategies for Narrowing Gaps

As the Bangladesh-Pakistan study of irrigation wells suggests, it is not inevitable that innovations will widen socioeconomic gaps within a social system. But such gap-widening inequality will usually occur unless a change agency devotes special efforts to prevent it. In the Bangladesh illustration, the change agency had organized cooperatives so that this social organization in which the technology (of irrigation wells) was imbedded helped prevent any widening of the socioeconomic gap.

What other strategies for gap narrowing can be used by change agencies? We list some possible strategies here, organized under some of the major reasons why socioeconomic gaps ordinarily widen as a consequence of innovations.

I. THE "UPS" HAVE GREATER ACCESS TO INFORMATION CREATING AWARENESS ABOUT INNOVATIONS THAN THE "DOWNS."

1. Messages that are redundant or that are of less interest and/or benefit to the higher socioeconomic subaudience, but that are appropriate and of interest to the lower socioeconomic subaudience, can be provided. This strategy enables the lower socioeconomic subaudience to catch up. This "ceiling effect" strategy was used successfully in narrowing the socioeconomic gap in India through television programming for villagers (Shingi and Mody, 1976), as we will detail shortly.

2. One can tailor communication messages especially for the lower socioeconomic subaudience in terms of their particular characteristics, such as education, beliefs, communication habits, and the like. Communication materials are often not especially designed for this audience segment, and hence are often ineffective. Although the basic content of these messages may be the same as for the "Ups," to be effective in reaching the lower socioeconomic audience, the

message design, treatment, and presentation may need to be different; for example, more line drawings, photographs, and other visual aids may be needed because of the lower levels of formal education among the "Downs." Sources and producers of innovation messages are usually more homophilous with the "Ups" than they are with the "Downs," so their messages are usually more appropriate for the "Ups"; in order to communicate more effectively with the "Downs," change agents need to be able to empathize with them. Formative evaluation* may be especially helpful in producing effective messages for the "Downs," such as by pretesting prototype messages before they are produced in large quantities.

3. One should use communication channels that are particularly able to get through to the "Downs" so that access is not a barrier to their gaining awareness-knowledge of innovations. In the United States, for example, lower socioeconomic audiences are especially heavy television viewers but depend less on print media than do the "Ups." In developing nations, a high percentage of the "Downs" may not possess literacy skills, so print media are out; the "Downs" are much more likely to have radio exposure than to view television. The "Downs" in developing nations also can be uniquely reached through traditional communication channels such as puppet shows, story tellers, folk operas, traditional midwives, and at traditional gathering places such as markets, mosques, temples, teahouses, or taverns. These credible and culturally accepted communication media are especially appropriate for the lower socioeconomic subaudience in many nations (Rogers, 1973).

4. The "Downs" can be organized in small groups in which they can learn about innovations and discuss these new ideas. Illustrations of such a group approach to communicating with the disadvantaged subaudience are radio forums in many Asian and African nations, radiophonics "schools" in Latin America, mothers' clubs in South Korea, village co-ops in Bangladesh, and others. Such little groups provide an avenue for mass media exposure by the poor, or for direct contact by change agents. And the group context for listening, discussion, and action provides a basis for the "Downs" to gain efficacy, a feeling that they have control over their environment.*

* *Formative evaluation* is a type of research that is conducted while an activity, process, or system is ongoing, in order to improve its effectiveness. In contrast, *summative evaluation* is a type of research that is conducted in order to reach a decision about the effectiveness of an activity, process, or system after it has run its course. By being carried out when a communication message is "in process," formative evaluation can improve the effectiveness of message design; it is most important when the source and audience are heterophilous.

5. The concentration of change agent contact can be shifted from the innovators and early adopters, where it has been in the past (Chapter 9), to the late majority and laggards. These later adopting categories tend to place less credibility in professional change agents, and they are seldom active in searching for information from them, as they place greater trust in interpersonal networks with their peers. But on those fairly rare occasions in the past when change agents have directly contacted late majority and laggards, and where the innovations are appropriate to their needs, the response has often been encouraging (Roling et al, 1976). In the past, change agents have often followed an implicit strategy of "betting on the strong." They need to pursue alternative contact strategies of concentrating on the weak, if greater equality in the distribution of the benefits of innovations is to be achieved.

But there is a cost of gap-narrowing activities by change agents; they cannot be increasing the total Good in a system while they are attempting to secure a more equitable distribution of Good (Figure 11-3). To illustrate the conflict between the first and the second dimensions of diffusion consequences, consider a relatively simple case of a change agent working in a single village. One farmer owns one hundred acres, while each of the remaining one hundred farmers operates an average of one acre. If the change agent contacts the one hundred smaller farmers, he may be able to get them to adopt new crop varieties, chemical fertilizers, and other agricultural chemicals, so that their yields increase an average of ten bushels per acre within a few years. But with much less effort, the change agent could contact the one large-sized farmer, who is already innovative and receptive to new ideas; an increase of ten bushels per acre on the elite individual's farm equals the consequences of the much greater efforts by the change agent with all one hundred smaller farmers.

So there is a much greater cost to the gap-closing strategies of change agencies. For one thing, a much greater number of change agents may be needed to serve the same client systems. In Latin

* Once the "Downs" are organized in small groups, and gain a sense of efficacy, they do not always act as obedient, passive clients of a change agency. They may turn the small groups to political ends or engage in various antiestablishment acts. An illustration is the mothers' club in Korea, organized to diffuse family planning, which destroyed the men's drinking place in their village (Rogers and Kincaid, 1981).

America, each agricultural extension worker is expected to serve an average of about 10,000 farmers (Rogers et al, 1982a). How would you like to try to contact 10,000 clients? Clearly it is an impossible task. And because small farmers in Latin America are not politically powerful, it will be difficult for agricultural development agencies to obtain the funding they would need to reach the millions of small farmers in their nations. But certain international agencies, such as the World Bank, now fund such small-farmer diffusion programs in many developing nations.

II. THE "Ups" HAVE GREATER ACCESS TO INNOVATION-EVALUATION INFORMATION FROM PEERS THAN THE "DOWNS."

If the trickle-down theory were operating perfectly, the "Downs" would rapidly learn of the "Ups" personal experience from having adopted an innovation, and quickly follow suit (at least if the innovation were appropriate). But the reality of communication networks in many systems is that "Ups" talk to "Ups," and "Downs" to "Downs" (Roling et al, 1976). So the "Downs" are often not interconnected in interpersonal networks about innovations. How can this problem be overcome?

1. The opinion leaders among the disadvantaged segment of a system can be identified and change agent contacts can be concentrated on them, so as to activate peer networks about an innovation. Roling and others (1976) report success with this approach in Kenya. Late majority and laggards have their opinion leaders, although they may not be as easily identified in a system as the opinion leaders among the early adopters and early majority (Chapter 8).

2. Change agent aides who are selected from among the "Downs" can be used to contact their homophilous peers about innovations (Chapter 9).

3. Formal groups among the "Downs" can be organized to provide them with leadership and social reinforcement in their innovation decision making. Such small groups give the "Downs" greater economic, political, and social strength (as we saw in the example of the Bangladesh village cooperatives). A group approach provides an avenue for the change agent to modify and shape the interpersonal communication structure of a system.

III. THE "Ups" POSSESS GREATER SLACK RESOURCES FOR ADOPTING INNOVATIONS THAN THE "DOWNS."

Perhaps as an artifact of gaining (or having gained) their original superior status, the "Ups" are usually much more able to adopt innovations, particularly if these new ideas are expensive, technologically complex, and if they provide economies of scale. What strategies can help overcome these gap-widening tendencies?

1. Priority can be given to developing and recommending appropriate innovations for the "Downs." In order for such appropriate technologies to be available, R&D activities should previously have been directed at the problems and needs of the lower socioeconomic members of a system (Chapter 4). There has been a general tendency for R&D in many fields to be conducted on the problems of the "Ups." For example, a national agricultural research center in one Latin American nation mainly studied the needs and problems of large commercial farmers who raised cotton and sugar cane for export until the early 1970s; since then, they have also begun to devote research to potatoes and yucca, the main subsistence crops grown by the nation's millions of small farmers. As a result, rural development agencies are now beginning to have some useful innovations for smaller farmers to adopt.

2. A social organization can be provided at the local level so that the "Downs" can gain parity with the "Ups" in their ability to command the slack resources needed to adopt certain high-cost innovations. We saw an illustration of this social-organization strategy in the village co-ops in Bangladesh (Gotsch, 1972).

3. A means should be provided whereby the "Downs" can participate in the planning and execution of diffusion programs, including the setting of program priorities. This participation strategy usually means that some sort of organizational structure must be established through which the "Downs" can make their needs and problems known to officials in a change agency. The notion of participation implies that "clients" should be perceived by change agents as active participants in a communication process, not just as passive receivers in a one-way, linear communication flow.

4. Special diffusion agencies could be established to work only with the "Downs," thus enabling change agents to meet the particular needs of the lower socio-economic audience. This strategy has been effectuated in various nations, including the United States, in the form

of small farmers' development agencies, small businessmen's assistance agencies, and in special programs to assist disadvantaged schools. If such an agency had existed among the Colombian coffee growers studied by Havens and Flinn (1975), for example, it might have provided agricultural credit to the small farmers so that they could have afforded to adopt the new coffee varieties.

5. Emphasis should be shifted from diffusing innovations coming out of formal R&D to spreading information about experience-based ideas through a more decentralized diffusion system (Chapter 9). An investigation by O'Sullivan (1978) among Guatemalan Indian farmers found that they could not afford to adopt most of the agricultural innovations promoted by development agencies; for instance, these subsistence peasants could not afford to purchase chemical fertilizer. But numerous low-cost innovations could have been disseminated by the change agents, such as the closer planting of corn plants (the main crop grown by these Indian farmers). The general point here is that formal R&D is not the only source of useful innovations; they can also come from clients' everyday experience. This fact has usually been overlooked by change agents in the past.

Wider Gaps Are Not Inevitable

Recent field experiments by Shingi and Mody (1976) and Roling et al (1976) suggest Generalization 11-7: *When special efforts are made by a diffusion agency, it is possible to narrow, or at least not to widen, socioeconomic gaps in a social system.* In other words, widening gaps are not inevitable. Significantly, both of the diffusion studies reviewed Here were designed, at least implicitly, to test gap-narrowing strategies under field conditions.

The Shingi and Mody (1976) field experiment in India was designed to evaluate the ceiling effect strategy, identified in the previous section as Strategy 1-1: Provide messages, that are redundant or that are of less interest and/or benefit to the "Ups," but that are appropriate and of interest to the lower socioeconomic sub-audience. In this ingenious study, two Indian communication scholars, Dr. Prakash M. Shingi and Dr. Bella Mody, first content-analyzed a series of agricultural television programs (before they were broadcast) in order to determine the twenty-one main items of information about wheat-growing and potato-raising innovations that the programs contained. The television programs were designed to provide useful information to the majority of smaller farmers in India, but to be redundant with much of the information already possessed by larger farmers. In terms of Figure 10-4b, one might think of a ceiling line drawn across the vertical ordinate at about five units of effect; thus, the television programs could bring the "Ups" only a little way, allowing the "Downs" to catch up with them in their degree of agricultural knowledge.

In fact, this is exactly what Shingi and Mody (1976) found occurred; larger-sized farmers only watched a few of the televised programs before they were "turned off' by viewing agricultural information that they already knew. But the smaller-sized farmers eagerly attended to the television series because the farm information that it contained was still new to them. It should be noted here that all farmers had unlimited access to viewing the programs on a community television set that was provided to each village by the government of India (Strategy 1-3, dealing with access). Shingi and Mody (1976) measured the degree of agricultural knowledge both before and after the television programs, by means of personal interviews. They found that the gap between the "Ups" and the "Downs" was narrowed by the programs because of the ceiling effect: "By choosing program content that large farmers already understand, television producers can *close rather than widen* the communication effects gap" (emphasis in original).

The Shingi and Mody (1976) study suggests that television is inherently appropriate to reaching all segments of a mass audience, if the medium is managed to this end. The Indian researchers concluded that *"The communication effects gap is by no means inevitable.* It can be avoided if appropriate communication strategies are pursued in development effort" (emphasis in original).

Further evidence to this effect is provided by the Roling and others (1976) field experiment in Kenya.* These diffusion scholars selected 308 Kenyan farmers who had not previously adopted hybrid-seed corn, even though this innovation had been introduced to the community of study about nine years previously. The innovators and early adopters were already using hybrid corn at the time of the study, but the innovation had not "trickled down" to later adopters because the who-to-whom networks in Kenyan communities were very horizontal (that is, earlier adopters talked to earlier adopters). The 308 "laggards" were invited to participate in a series of local training courses

* Other publications from this investigation are Ascroft et al (1972, 1973).

in which small groups of the laggards were taught about hybrid-seed corn and such related innovations as using chemical fertilizers (Strategy II-2). And they were provided with agricultural credit, which most of the laggards needed to adopt the innovation (Strategy II-4).

As a result, 90 percent of the 308 "laggards" adopted the innovation. And within two years, a follow-up survey disclosed that the average farmer trainee had diffused the innovation to three other peers. So interpersonal networks were activated by the training course and the trainees' subsequent adoption (Strategy II-l).

Roling et al (1976) concluded that: "Diffusion generalizations adequately draw conclusions about current practice, but this may be very different from offering recommendations for optimal practice." The Kenya experiment helps show how diffusion programs can break outside the bounds of their current practice, and find ways to narrow, rather than widen, socioeconomic gaps. Frequently the means to break the intellectual bounds of conventional wisdom, as in the Kenya example, is via a field experiment (Rogers, 1973). So here we see the special power of field experiments by diffusion researchers in influencing the policies and strategies of change agencies.

Summary and Conclusions

Consequences are the changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation. Although of obvious importance, the consequences of innovations have received little attention by change agents or by diffusion researchers, who have concentrated primarily on investigating the correlates of innovativeness. Here we proposed a new model to guide future inquiries in which the main dependent variable is consequences.

Consequences have not been studied adequately because (1) change agencies have overemphasized adoption per se, assuming that the consequence will be positive; (2) the usual survey research methods may be inappropriate for investigating consequences; and (3) consequences are difficult to measure.

Consequences are classified as (1) desirable versus undesirable, (2) direct versus indirect, and (3) anticipated versus unanticipated. *Desirable consequences* are the functional effects of an innovation to

an individual or to a social system. *Undesirable consequences* are the dysfunctional effects of an innovation to an individual or to a social system. It is often difficult to avoid value judgments when evaluating consequences as desirable or undesirable. In fact, many innovations cause both positive and negative consequences, and it is thus erroneous to assume that the desirable impacts can be achieved without also experiencing the undesirable effects. But this assumption of separability frequently occurs. We conclude, however, that it is usually difficult or impossible to manage the effects of an innovation so as to separate the desirable from the undesirable consequences (Generalization 11-1).

Direct consequences are the changes to an individual or a social system that occur in immediate response to an innovation. *Indirect consequences* are the changes to an individual or a social system that occur as a result of the direct consequences of an innovation.

Anticipated consequences are changes due to an innovation that are recognized and intended by the members of a social system. *Unanticipated consequences* are changes due to an innovation that are neither intended nor recognized by the members of a social system.

The undesirable, indirect, and unanticipated consequences of innovations usually go together, as do the desirable, direct, and anticipated consequences (Generalization 11-2). We saw an illustration of this generalization in the introduction of the steel ax among Australian aborigines, which brought many undesirable, indirect, and unanticipated consequences, including breakdown of the family structure, the emergence of prostitution, and "misuse" of the innovation itself. The story of the steel ax illustrates three intrinsic elements of an innovation: (1) *form,* the directly observable physical appearance and substance of an innovation, *(2) function,* the contribution made by the innovation to the way of life of members of the social system, and (3) *meaning,* the subjective and frequently subconscious perception of the innovation by members of the social system. Change agents can more easily anticipate the form and function of an innovation for their clients than its meaning (Generalization 11-3).

In determining an ideal rate of change in a system, the concept of equilibrium must be considered. *Stable equilibrium* occurs when there is almost no change in the structure or functioning of a social system. *Dynamic equilibrium* occurs when the rate of change in a social system is commensurate with the system's ability to cope with it. *Disequilibrium* occurs when the rate of change is too rapid to permit the

social system to adjust. Change agents generally wish to achieve a rate of change that leads to dynamic equilibrium, and to avoid a state of disequilibrium.

As the dominant paradigm of development began to be questioned in the early 1970s, and various alternatives to it were explored, the importance of equality as an important consequence of diffusion activities began to be realized. One goal of diffusion programs is to raise the level of Good in a system; but a second dimension of consequences is whether the distribution of Good among the members of a system becomes more or less equal. The consequences of the adoption of innovations usually tend to widen the socioeconomic gap between the earlier and later adopting categories in a system (Generalization 11-4). Further, the consequences of the adoption of innovations usually tend to widen the socioeconomic gap between the audience segments previously high and low in socioeconomic status (Generalization 11-5).

A system's social structure partly determines the equality versus inequality of an innovation's consequences (Generalization 11-6). When a system's structure is already very unequal, the consequences of an innovation (especially if it is a relatively high-cost innovation) will lead to even greater inequality in the form of wider socioeconomic gaps.

What strategies could be followed in order to narrow gaps? The answer depends on three main reasons why socioeconomic gaps ordinarily widen as a consequence of innovations: (1) the "Ups" have greater access to information creating awareness about innovations; (2) they have greater access to innovation-evaluation information from peers; and (3) the "Ups" possess greater slack resources for adopting innovations than the "Downs."

When special efforts are made by a diffusion agency, it is possible to narrow, or at least not to widen, socioeconomic gaps in a social system (Generalization 11-7). In other words, widening gaps are not inevitable.

By following one or more of the various diffusion strategies detailed in the present chapter, it might be possible to avoid widening the socioeconomic gap between the "Ups" and the "Downs," and perhaps even to narrow this gap in some cases. Whether or not these strategies, or others like them, are followed by a change agency depends upon its goals and upon how these objectives are carried out through the agencies' policies. The important turning point that occurred in the early 1970s is that, in most countries of the world, change

agencies began to become more fully aware of the issue of widening gaps and increasing inequalities. They then began to adopt goals and policies concerning greater equality in the distribution of the consequences of innovations. Many change agencies are today searching for effective strategies to narrow, rather than widen, socioeconomic gaps.

One important role for diffusion research in the future is to explore more effective strategies for creating a greater degree of equality among the members of social systems. This is a new, difficult, and promising role for diffusion scholars.

Bibliography

THIS BIBLIOGRAPHY INCLUDES (1) all of the publications cited in the present book, and (2) a number of other diffusion publications, especially those that appeared in the past decade. The present bibliography does not include all of the 3,085 diffusion publications (2,297 empirical and 788 nonempirical*) currently available, as such a complete bibliography would constitute a book by itself. Most of the important work on the diffusion of innovations, however, is included either in the present bibliography or in my previous book on diffusion (Rogers with Shoemaker, 1971, pp. 387-460).

Each of the diffusion publications that follows is coded (1) as to the diffusion research tradition of the author, as indicated by his or her institutional affiliation at the time of publication (see list of codes below), and (2) as to whether it is empirical *(E)* or nonempirical *(N):*

Author's Diffusion Research Tradition	*Code for Tradition*
Anthropology	A
Agricultural Economics	AE
Communication	C
Education	E
Early Sociology	ES
Extension Education**	EX
Geography	G
General Economics	GE
General Sociology	GS
Industrial Engineering	I
Journalism***	J
Marketing	MR
Medical Sociology and Public Health	MS
Psychology	P
Public Administration	PA
Rural Sociology	RS
Statistics	S
Speech	SP
Others	O
Unclassifiable	u

* Nonempirical diffusion publications include bibliographies, theoretical writings, and summaries of diffusion findings reported in other, empirical publications.

**This category of extension education is frequently combined with the rural sociology tradition in the analyses presented in this book, as explained in Chapter 2.

*** This category of journalism is frequently combined with the communication tradition in this book.

Abdella, Mokhtar, et al (1981), "Adoption Behavior in Family Farm Systems: An Iowa Study," *Rural Sociology,* 46:42-61. RS(E)

Abernathy, William J., and James M. Utterback (1978), "Patterns of Industrial Innovation," *Technology Review,* 80:1-9. MR(N)

Achilladelis, B., et al (1971), *Project Sappho: A Study of Success and Failure in Innovation,* Brighton, England, University of Sussex, Science Policy Research Unit, Report.

Agarwala-Rogers, Rekha, et al (1977), "Diffusion of Impact Innovations from 1973-1976: Interpersonal Communication Networks among University Professors," Stanford, California, Applied Communication Research, Report. C(*E*)

Alba, Richard D., and Charles Kadushin (1976), "The Introduction of Social Circles: A New Measure of Social Proximity in Networks," *Sociological Methods and Research,* 5:77-102.

Allahabad Agricultural Institute (1957), "Extension Evaluation," Allahabad, India, Allahabad Agricultural Institute. EX(*E*)

Allan, Glenn S., and W. C. Wolf, Jr. (1978), "Relationships between Perceived Attributes of Innovations and Their Subsequent Adoption," *Peabody Journal of Education,* 55:332-336. E(*E*)

Allen, Harley Earl (1956), "The Diffusion of Educational Practices in the School Systems of the Metropolitan School Study Council," Ph.D. Thesis, New York, Columbia University, Teachers College—E(*E*)

Allison, Paul D. (1978), "Measures of Inequality," *American Sociological Review,* 43:865-880.

Arensberg, Conrad M., and Arthur H. Niehoff (1964), *Introducing Social Change,* Chicago, Aldine. A(*N*)

Arndt, Johan (1967), "Perceived Risk, Sociometric Integration, and Word of Mouth in the Adoption of a New Food Product," in Raymond M. Haas (ed.), *Science, Technology and Marketing,* Chicago, American Marketing Association. MR(*E*)

_____(1967), "Role of Product-Related Conversation in the Diffusion of a New Product," *Journal of Marketing Research,* 4:291-295. MR(*E*)

_(1971), "Exploring Consumer Willingness To Buy New Products," *Markeds Kommunikasjon,* 8:1-12. MR(*E*)

_____(1972), "Intrafamilial Homogeneity for Perceived Risk and Opinion Leadership," *Markeds Kommunikasjon,* 9:1-10. MR(*E*)

____(1978), "How Broad Should the Marketing Concept Be?" *Journal of Marketing,* 42:101-103. MR(*N*)

Arrow, Kenneth (1962), "The Economic Implications of Learning by Doing," *Review of Economic Studies,* 29:155-173.

Ascroft, Joseph R., et al (1969), *Patterns of Diffusion in Rural Eastern Nigeria,* East Lansing, Department of Communication, Michigan State University, Report. C(*E*)

_____(1972), *The Tetu Extension Project—First Report on a Field Experiment,* Nairobi, Kenya, University of Nairobi, Institute for Development Studies, Mimeo Report. C(*E*)

_____(1973), *Extension and the Forgotten Farmer,* Nairobi, Kenya, University of Nairobi, Institute for Development Studies, Bulletin 37. *C(E)*

Ashby, Jacqueline, and E. Walter Coward, Jr. (1980), "Putting Agriculture Back into the Study of Farm Practice Innovation: Comment on Status, Knowledge and Innovation," *Rural Sociology,* 45:520-523. RS(*N*)

Babcock, Jarvis M. (1962), "Adoption of Hybrid Corn—A Comment," *Rural Sociology,* 27:332-338. AE(*N*)

Bagehot, Walter (1873), *Physics and Politics,* New York, Appleton-Century.

Bailey, Norman T. J. (1957), *The*

Mathematical Theory of Epidemics, New York, Hafner.

Baker, Norman R., and Dennis J. Sweeney (1977), *An Assessment of Modeling Capability Related to the Process of Organized Technological Innovation within the Firm, Volume II: Final Technical Report,* Cincinnati, Ohio, University of Cincinnati, College of Business Administration, Report. MR(*N*)

Bandura, Albert (1977), *Social Learning Theory,* Englewood Cliffs, New Jersey, Prentice-Hall.

Banta, H. David (1980), "The Diffusion of the Computer Tomography (CT) Scanner in the United States," *International Journal of Health Services,* 10:251-269. MS(*N*)

_____(1981), "Major Issues Facing Biomedical Innovation," in Edward B. Roberts et al (eds.), *Biomedical Innovation,* Cambridge, Massachusetts, MIT Press. MS(*N*)

Barghouti, Shawki M. (1974), "The Role of Communication in Jordan's Rural Development," *Journalism Quarterly,* 51:418-424. C(*E*)

Barnett, Homer G. (1953), *Innovation: The Basis of Cultural Change,* New York, McGraw-Hill. A(*E*)

Barton, Allen (1968), "Bringing Society Back In: Survey Research and Macro-Methodology," *American Behavioral Scientist,* 12:1-9.

Battelle-Columbus Laboratories (1976), *Report of the President's Biomedical Research Panel: Analysis of Selected Biomedical Research Programs: Case Histories,* Columbus, Ohio, Battelle-Columbus Laboratories, Report to the U.S. Public Health Service.

Beal, George M., et al (1957), "Validity of the Concept of Stages in the Adoption Process," *Rural Sociology,* 22:166-168. RS(*E*)

Beal, George M., and Everett M. Rogers (1957), "Informational Sources in the Adoption Process of New Fabrics," *Journal of Home Economics,* 49:630-634. RS(*E*)

(1960), *The Adoption of Two Farm Practices in a Central Iowa Community,* Ames, Iowa Agricultural and Home Economics Experiment Station, Special Report 26.

Becker, Marshall H. (1970), "Factors Affecting Diffusion of Innovations among Health Professionals," *American Journal of Public Health,* 60:294-305. MS(*E*)

_ (1970), "Sociometric Location and Innovativeness: Reformulation and Extension of the Diffusion Model," *American Sociological Review,* 35:262-282. MS(*E*)

Beltran S., Luis Ramiro (1976), "Alien Premises, Objects, and Methods in Latin American Communication Research," *Communication Research,* 3:107-134. C(*N*)

Berelson, Bernard, and Ronald Freedman, (1964), "A Study in Fertility Control," *Scientific American,* 210; 29-37. MS(*E*)

Berman, Paul, and Milbrey W. McLaughlin (1974), *Federal Programs Supporting Educational Change, Vol. 1: A Model of Educational Change,* Santa Monica, California, Rand Corporation, Report. E(*E*)

_(1975), *Federal Programs Supporting Educational Change, Vol. 4: The Findings in Review,* Santa Monica, California, Rand Corporation, Report. *E(E)*

_(1978), *Federal Programs Supporting Educational Change, Vol. VIII: Implementing and Sustaining Innovations,* Santa Monica, California, Rand Corporation. *E(E)*

Berman, Paul, et al (1975), *Federal Programs Supporting Educational Change, Vol. V: Executive Summary,* Santa Monica, California, Rand Corporation, Report. *E(E)*

_____(1977), *Federal Programs Supporting Educational Change: Vol. VII: Factors Affecting Implementation and Continuation,* Santa Monica, California, Rand Corporation. E(*E*)

Berman, Paul, and Edward W. Pauly, (1975), *Federal Programs Supporting Educational Change, Vol. 2: Factors Affecting Change Agent Projects,* Santa Monica, California, Rand Corporation, Report. E(*E*)

Bernas, M. Bellarmine (1981), *The Innovation Process of Individualized Instruction in Some Elementary Schools in the Philippines: Towards a Model of an Innovation Process in Educational Organizations,* Ph.D. Thesis, Stanford, California, Stanford University. E(*E*)

Bingham, Richard (1976), *The Adoption of Innovation by Local Government,* Lexington, Massachusetts, Heath.

Bingham, Richard D., and John P. Frendreis (1978), "Innovation Characteristics and the Adoption of Zero-Base Budgeting: Agreement and Conflict in City Administration," Paper presented at the Midwest Political Science Association, Chicago. PS(*E*)

Bishop, Rowland, and C. Milton Coughenour (1964), *Discontinuance of Farm Innovations,* Columbus, Ohio State University, Department of Agricultural Economics and Rural Sociology, Mimeo Bulletin AE 361. RS(*E*)

Bordenave, Juan Diaz (1976), "Communication of Agricultural Innovations in Latin America: The Need for New Models," *Communication Research,* 3:135-154. C(*N*)

Bose, Santi Priya (1964), "The Diffusion of a Farm Practice in Indian Villages," *Rural Sociology,* 29:53-66. RS(*E*)

Bowden, Leonard W. (1965), *Diffusion of the Decision to Irrigate: Simulation of the Spread of a New Resource Management Practice in the Colorado Northern High Plains,* Chicago, Illinois, University of Chicago, Department of Geography, Research Paper 97. *G(E)*

_ (1965), *Pump Irrigation in the Colorado Northern High Plains,* Ph.D. Thesis, Worcester, Massachusetts, Clark University. *G(E)*

Bowers, Raymond V. (1937), "The Direction of Intra-Societal Diffusion," *American Sociological Review,* 2:826-836. ES(*E*)

_(1938), "Differential Intensity of Intra-Societal Diffusion," *American Sociological Review,* 3:21-31.

Boyd, John Paul (1980), "Three Orthogonal Models of Adoption of Agricultural Innovation," *Rural Sociology,* 45:309-324. RS(*E*)

Brandner, Lowell (1960), *Evaluation for Congruence as a Factor in Accelerated Adoption of an Agricultural Innovation,* Ph.D. Thesis, Madison, University of Wisconsin. *C(E)*

Brandner, Lowell, and Bryant Kearl, (1964), "Evaluation for Congruence as a Factor in Adoption Rate of Innovations," *Rural Sociology,* 29:288-303. RS(*E*)

Brandner, Lowell, and Murray A. Straus, (1959), "Congruence Versus Profitability in the Diffusion of Hybrid Sorghum," *Rural Sociology,* 24:381-383. RS(*E*)

Braun, Ernest, and Stuart MacDonald (1978), *Revolution in Miniature: The History and Impact of Semiconductor Electronics,* London, Cambridge University Press.

Brown, Lawrence Alan (1966), *Diffusion Dynamics: A Review and Revision of the Quantative Theory of the Spatial Diffusion of Innovation,* Ph.D. Thesis, Evanston, Illinois, Northwestern University. *G(N)*

Brown, Lawrence A. (1981), *Innovation Diffusion: A New Perspective,* New York, Methuen. *G(N)*

Brown, L. A., and E. G. Moore (1969),

"Diffusion Research in Geography: A Perspective," *Progress in Geography*, 1:121-157. *G(N)*

Brown, Lawrence A., et al (1976), "Adopter Categories in a Spatial Context: Alternative Explanations for an Empirical Regularity," *Rural Sociology*, 41:99–118. *G(E)*

Burt, Ronald S. (1980), "Innovation as a Structural Interest: Rethinking the Impact of Network Position on Innovation Adoption," *Social Networks*, 2:327-355. GS(*N*)

Cancian, Frank (1967), "Stratification and Risk-Taking: A Theory Tested on Agricultural Innovation," *American Sociological Review*, 32:912-927.

(1976), "Reply to Morrison, Kumar, Rogers and Fliegel," *American Sociological Review*, 41:919-923.

(1977), *The Innovator's Situation: Upper-Middle-Class Conservatism in Agricultural Communities*, Irvine, University of California, School of Social Science, Working Paper 132. A(*E*)

(1979a), "A Useful Distinction between Risk and Uncertainty," Irvine, University of California, School of Social Science, Report. A(*N*)

_(1979b), *The Innovator's Situation: Upper-Middle-Class Conservatism in Agricultural Communities*, Stanford, California, Stanford University Press. A(*E*)

_(1980), "Risk and Uncertainty in Agricultural Decision-Making," in Peggy F. Bartlett (ed.), *Agricultural Decision-Making*, New York, Academic Press. A(*E*)

_(1981), "Community of Reference in Rural Stratification Research," *Rural Sociology*, 46:626-645. *A(E)*

Caplan, Nathan, and Stephen D. Nelson (1973), "On Being Useful: The Nature and Consequences of Psychological Research on Social Problems," *American Psychologist*, 28:199–211.

_(1974), "Who's to Blame?" *Psychology Today*, 8:99-104.

Carlson, Richard O. (1965), *Adoption of Educational Innovations*, Eugene, University of Oregon, Center for the Advanced Study of Educational Administration. *E(E)*

Carlson, Robert C. (1976), "Anatomy of a Systems Failure: Dial-A-Ride in Santa Clara County, California." *Transportation*, 5:3-16.

Carroll, Tom W. (1969), *Computer Simulation of the Diffusion of Dairy Innovations in a Rural Community of Brazil*, Ph.D. Thesis, Cambridge, Massachusetts Institute of Technology, Department of Political Science. PS(*E*)

Carson, Rachel (1962), *Silent Spring*, New York, Fawcett Crest.

Case, Donald, et al (1982), *Stanford Evaluation of the Green Thumb Box Experimental Videotext Project for Agricultural Extension Delivery in Shelby and Todd Counties, Kentucky*, Stanford, California, Stanford University, Institute for Communication Research, Report to the U.S. Department of Agriculture.

Charters, W. W., Jr., and Roland S. Pellegrin (1972), "Barriers to the Innovation Process: Four Case Studies of Differentiated Staffing," *Educational Administrative Quarterly*, 9:3-4. *E(E)*

Choi, Hyup (1979), *An Evaluation of the Introduction of an Agricultural Innovation in Kentucky: A Case Study of No-Tillage Farming in Christian County*, Ph.D. Thesis, Lexington, University of Kentucky. RS(*E*)

Choi, Hyup, and C. M. Coughenour (1979), *Socioeconomic Aspects of No-Tillage Agriculture: A Case Study of Farmers in Christian County, Kentucky*, Lexington, Kentucky Agricultural Experiment Station, Report RS-63. RS(*E*)

Clinton, Alfred (1973), *A Study of the Attributes of Educational Innovations as Factors in Diffusion*, Ph.D. Thesis, University of Toronto. E(*E*)

Coleman, James S. (1958), "Relational Analysis: The Study of Social Organizations with Survey Methods," *Human Organization*, 14:28-36.

Coleman, James, et al (1957), "The Diffusion of an Innovation among Physicians," *Sociometry*, 20:253-270. MS(*E*)

Coleman, James, et al (1957), "The Diffusion of an Innovation among Physicians," *Sociometry*, 20:253-270. MS(*E*)

_____(1959), "Social Processes in Physicians' Adoption of a New Drug," *Journal of Chronic Diseases*, 9:1-19. MS(*E*)

_____(1966), *Medical Innovation: A Diffusion Study*, New York, Bobbs-Merrill. MS(*E*)

Comroe, Julius H., Jr., (1977), *Retrospectroscope: Insights into Medical Discovery*, Menlo Park, California, Von Gehr Press.

Conner, John T. (1964), "Progress Reshapes Competition," *Printers' Ink*, 287:36.

Consumer Dynamics, Inc. (1980), *Conclusions on the Effects of Decision-making Behavior on the Use of Information*, Rockville, Maryland, Consumer Dynamics, Inc., Report to the U.S. Department of Agriculture, Science and Education Administration, Technical Information Systems, National Agricultural Library.

Cock, Thomas D., et al (1975), *"Sesame Street" Revisited*, New York, Russell Sage Foundation.

Copp, James H., et al (1958), "The Function of Information Sources in the Farm Practice Adoption Process," *Rural Sociology*, 23:146-157. RS(*E*)

Copus, Gary Dean (1972), *Structuring Influence of Attributes of Farm Information Flow*, Ph.D. Thesis, Columbia, University of Missouri. RS(*E*)

Coughenour, C. Milton (1961), "The Practice-Use Tree and the Adoption, Drop-out, and Non-Adoption of Recommended Farm Practices: A Progress Report," Paper presented at Rural Sociological Society, Ames, Iowa. RS(*N*)

_____(1964), "Toward a Theory of the Diffusion of Technology," Paper presented at the First Interamerican Research Symposium on the Role of Communications in Agricultural Development, Mexico City. RS(*N*)

_(1965), "The Problem of Reliability of Adoption Data in Survey Research," *Rural Sociology*, 30:184-203.

Crane, Diana (1972), *Invisible Colleges*, Chicago, Illinois, University of Chicago Press. GS(*E*)

Crouch, Bruce R. (1981), "Innovation and Farm Development: A Multidimensional Model," in Bruce R. Crouch and Shankariah Chamela (eds.), *Extension Education and Rural Development*, New York, Wiley. RS(*E*)

Cyert, Richard M., and James G. March (1963), *A Behavioral Theory of the Firm*, Englewood Cliffs, New Jersey, Prentice-Hall.

Danziger, James N. (1977), "Computers, Local Governments, and the Litany to EDP," *Public Administration Review*, 37:28-37. PS(*E*)

Deal, Terrence E., et al (1975), "Organizational Influences on Educational Innovation," in J. Victor Baldridge and Terrence E. Deal (eds.), *Managing Change in Educational Organizations: Sociological Perspectives, Strategies,*

and Case Studies, Berkeley, California, McCutchan. *E(E)*

Deutschmann, Paul J. (1963), "The Mass Media in an Underdeveloped Village," *Journalism Quarterly,* 40:27-35. *C(E)*

Deutschmann, Paul J., and Wayne A. Danielson (1960), "Diffusion of Knowledge of the Major News Story," *Journalism Quarterly,* 37:345-355. C(*E*)

Deutschmann, Paul J., and Orlando Fals Borda (1962), *La Comunicación de las Ideas entre los Campesinos Colombianos,* Bogota, Universidad Nacional de Colombia, Monografias Sociologicas 14. C(*E*)

_(1962), *Communication and Adoption Patterns in an Andean Village,* San Jose, Costa Rica, Programa Interamericano de Informacion Popular, Report. *C(E)*

Deutschmann, Paul J., and A. Eugene Havens (1965), "Discontinuances: A Relatively Uninvestigated Aspect of Diffusion," Unpublished Paper, Madison, University of Wisconsin, Department of Rural Sociology. *C(E)*

Dimit, Robert M. (1954), *Diffusion and Adoption ofApproved Farm Practices in 11 Counties in Southwest Virginia,* Ph.D. Thesis, Ames, Iowa State University. RS(*E*)

Dixon, Robert (1980), "Hybrid Corn Revisited," *Econometrica,* 48:1451-1461. *GE(E)*

Downs, George W., and Lawrence B. Mohr (1976), "Conceptual Issues in the Study of Innovations," *Administrative Science Quarterly,* 21:700-714.

Duff, Robert W., and William T. Liu (1975), "The Significance of Heterophilous Structure in Communication Flows," *Philippine Quarterly of Culture and Society,* 3:159-175. MS(*E*)

Dunlap, Thomas R. (1981), *DDT: Scientists, Citizens, and Public Policy,* Princeton, New Jersey, Princeton University Press.

Dvorak, August, et al (1936), *Typewriting Behavior,* New York, American.

Ebner, W. C. (1973), *The Diffusion, Adoption, and Implementation of a Nationally-Recognized Innovative Program in Special Education,* Ph.D Thesis, Los Angeles, University of Southern California. *E(E)*

Elliott, John G. (1968), *Farmers' Perceptions of Innovations as Related to Self-Concept and Adoption,* Ph.D. Thesis, East Lansing, Michigan State University. *EX(E)*

Emrick, John A., and Rehka Agarwala-Rogers (1978), "National Diffusion Network: An Emerging Strategy for Directed Change," *Viewpoints in Teaching and Learning,* 54:91-113. *E(E)*

Emrick, John A., et al (1977), *Evaluation of the National Diffusion Network, Vol. 1: Findings and Recommendations,* Menlo Park, California, Stanford Research Institute, Report. *E(E)*

Ericksen, Eugene P., et al (1980), "The Cultivation of the Soil as a Moral Directive: Population Growth, Family Ties, and the Maintenance of Community among the Old Order Amish,'' *Rural Sociology,* 45:49-68.

Eveland, J. D. (1979), "Issues in Using the Concept of 'Adoption of Innovation''', Baltimore, Maryland, Paper presented to the American Society for Public Administration. O(N)

Eveland, J. D., et al (1977), *The Innovation Process in Public Organizations,* Ann Arbor, University of Michigan, Department of Journalism, Mimeo Report. C(*E*)

Fairweather, George W., and Louis G. Tornatzky (1977), *Experimental Methods for Social Policy Research,* New York, Pergamon Press. *P(E)*

Fallaci, Oriana (1979), "An Interview with Khomeini," *New York Times,* October 7, pp. 29-31.

Fals Borda, Orlando (1960), *Facts and Theory of Socio-Cultural Change in a Rural Social System,* Bogota, Universidad Nacional de Colombia, Monografias Sociologicas 2 bis. RS(*E*)

Feller, Irwin (1979), "Three Coigns on Diffusion Research," *Knowledge: Creation, Diffusion and Utilization,* 1:393-412. GE(*N*)

_____(1980), "Managerial Response to Technological Innovations in Public Sector Organizations," *Management Science,* 26:1021-1030. GE(*E*)

Finley, James Richard (1965), *Prediction of the Adoption of Improved Farm Practices,* M.S. Thesis, Columbus, Ohio State University. RS(*E*)

Finley, James R. (1968), "Farm Practice Adoption: A Predictive Model," *Rural Sociology,* 33:5-18. RS(*E*)

Finkelstein, Stan N., et al (1981), *Biomedical Innovation: The Challenge and the Process,* Cambridge, Massachusetts Institute of Technology, Sloan School of Management, Report. MR(*E*)

Fiske, Emmett Preston (1980), *The College and Its Constituency: Rural and Community Development at the University of California 1875-1975,* Ph.D. Thesis, Davis, University of California at Davis.

Fliegel, Frederick C., and Joseph E. Kivlin (1962), *Differences Among Improved Farm Practices as Related to Rate of Adoption,* University Park, Pennsylvania Agricultural Experiment Station Research Bulletin 691. RS(*E*)

_____(1966), "Attributes of Innovations as Factors in Diffusion," *American Journal of Sociology,* 72:235-248. GS(*E*)

_(1966), "Farmers' Perception of Farm Practice Attributes," *Rural Sociology,* 31:197-206. RS(*E*)

Fliegel, Frederick C., et al (1967), *Innovation in India: The Success or Failure of Agricultural Development Programs in 108 Indian Villages,* Hyderabad, India, National Institute of Community Development, Research Report 9. *C(E)*

_____(1968), "A Cross-National Comparison of Farmers' Perceptions of Innovations as Related to Adoption Behavior," *Rural Sociology,* 33:437-449. RS(*E*)

Fox, Karen F. A., and Philip Kotler (1980), "The Marketing of Social Causes: The First Ten Years," *Journal of Marketing,* 44:24-33.

Francis, David G., and Everett M. Rogers, (1960), "Adoption of a Non-Recommended Innovation: The Grass Incubator," Paper presented at the Rural Sociological Society, University Park, Pennsylvania. RS(*E*)

Freedman, Ronald (1964), "Sample Surveys for Family Planning Research in Taiwan," *Public Opinion Quarterly,* 28:374-382. MS(*E*)

Freedman, Ronald, et al (1964), "Fertility and Family Planning in Taiwan: A Case Study in Demographic Transition," *American Journal of Sociology,* 70:16-27. MS(*E*)

Freedman, Ronald and John Y. Takeshita (1965), "Studies of Fertility and Family Limitation in Taiwan," *Eugenics Quarterly,* 12:233-250. GS *(E)*

_____(1969), *Family Planning in Taiwan,* New Jersey, Princeton University Press. MS(*E*)

Frey, R. Scott, and David M. Freeman (1981), "Stratification and Risk-Taking in Pakistan: A Reply to Cancian,'' *Rural Sociology,* 46:646-651. RS(*E*)

Frey, R. Scott, et al (1979), ''Cancian's 'Upper Middle Class Conservatism' Thesis: A Replication from Paki-

stan," *Rural Sociology,* 44:420-430.

Friedkin, Noah (1980), "A Test of Structural Features of Granovetter's Strength of Weak Ties Theory," *Social Networks,* 2:411-422.

_____(1981), "Observability in Inter-organizational Social Network," Santa Barbara, University of California at Santa Barbara, Department of Education, Unpublished Paper.

Friedland, William H., and Amy Barton (1975), *Destalking the Wily Tomato: A Case Study of Social Consequences in California Agricultural Research,* Santa Cruz, University of California at Santa Cruz, Research Monograph 15.

Friedland, William H., et al (1981), *Manufacturing Green Gold: Capital, Labor, and Technology in the Lettuce Industry,* New York, Cambridge University Press.

Fuller, Gary (1974), "On the Spacial Diffusion of Fertility Decline: The Distance-to-Clinic Variable in a Chilean Community," *Economic Geography,* 50:324-332. *G(E)*

Galloway, John J. (1974), *Substructural Rates of Change, and Adoption and Knowledge Gaps in the Diffusion of Innovations,* Ph.D. Thesis, East Lansing, Michigan State University. C(*E*)

Gantz, Walter, et al (1976), "The Impact of Salience and Altruism on the Diffusion of News," *Journalism Quarterly,* 54:727-732. *E(E)*

Gantz, Walter, and Sarah Trenholm (1979), "Why People Pass on News: Motivation for Diffusion," *Journalism Quarterly,* 56:365-370. *C(E)*

Garst, Ronald D. (1973), "Spatial Diffusion and Information Diffusion: A Kenyan Example," *Proceedings of the Association of American Geographers,* 5:75-80. *G(E)*

_____(1974), "Spacial Diffusion in Rural Kenya: The Impact of Infrastructure and Centralized Decision-making," Columbus, Ohio State University, Studies in the Diffusion of Innovations, Report. *C(E)*

_____(1975), "Spatial Diffusion in Rural Kenya: The Impact of Infrastructure and Centralized Decision Making," Columbus, Ohio State University, Department of Geography.

Gartrell, John W. (1977), "Status, Inequality and Innovation: The Green Revolution in Andra Pradesh, India," *American Sociological Review,* 42: 318-337. GS(*E*)

Gartrell, John W. and C. David Gartrell (1979), "Status, Knowledge and Innovation," *Rural Sociology,* 44:73-94.

Gartrell, John W. et al (1973), "Curvilinear and Linear Models Relating Status and Innovative Behavior: A Reassessment," *Rural Sociology,* 38:391-411.

Gillespie, Robert W. (1965), *Family Planning on Taiwan, 1964-1965,* Taichung, Taiwan, Population Council Mimeo Report. *C(E)*

Glaser, Edward M. (1981), "Durability of Innovations in Human Service Organizations: A Case-Study Analysis," *Knowledge,* 3:167-185. P(*E*)

Glaser, Rashi H., and David B. Montgomery (1980), *New Products and Innovations: An Annotated Bibliography,* Stanford, California, Stanford University, Graduate School of Business, Technical Report 35. MR(*N*)

Globe, Samuel et al (1973), *The Interactions of Science and Technology in the Innovative Process: Some Case Studies,* Columbus, Ohio, Battelle-Columbus Laboratories, Report to the National Science Foundation.

Goss, Kevin F. (1979), "Consequences of Diffusion of Innovations," *Rural Sociology,* 44(4):754–772. RS(*N*)

Gotsch, Carl H. (1972), "Technical Change and the Distribution of Income in Rural Areas," *American Journal of Agricultural Economics,* 54:326-341.

Graham, L. Saxon (1956), "Class and Conservatism in the Adoption of Innovations," *Human Relations,* 9:91-100. GS(£)

Granovetter, Mark S. (1973), "The Strength of Weak Ties," *American Journal of Sociology,* 78:1360-1380. GS(*N*)

_____(1978), "Threshold Models of Collective Behavior," *American Journal of Sociology,* 83:1420–1443. GS(*N*)

Granovetter, Mark (1980), "The Strength of Weak Ties: A Network Theory Revisited," Paper presented at the International Communication Association, Acapulco.

Gray, Virginia (1973), "Innovation in the States: A Diffusion Study," *American Political Science Review,* 67:1174–1185. PS(*E*)

_____(1973), "Rejoinder to 'Comment' by Jack L. Walker," *American Political Science Review,* 67:1192-1193. PS(*N*)

Green, Robert T., and Eric Langeard (1975), "A Cross-National Comparison of Consumer Habits and Innovator Characteristics," *Journal of Marketing,* 39:34-41. MR(*E*)

Green, Robert T., et al (1974), "Innovation in the Service Sector: Some Empirical Findings," *Journal of Marketing Research,* 11:323–326. MR(*E*)

Greenberg, Bradley S. (1964), "Diffusion of News about the Kennedy Assassination," *Public Opinion Quarterly,* 28:225-232, and in Bradley S. Greenberg and Edwin B. Parker (eds.) (1965), *The Kennedy Assassination and the American Public: Social Communication in Crisis,* Stanford, California, Stanford University Press. *C(E)*

Griliches, Zvi (1957), "Hybrid Corn: An Exploration in the Economics of Technological Change," *Econometrica,* 25:501-522. AE(*E*)

_____(1958), "Research Costs and Social Returns: Hybrid Corn and Related Innovations," *Journal of Political Economy,* 5:419-431. AE(*N*)

_____(1960), "Congruence Versus Profitability:A False Dichotomy," *Rural Sociology,* 25:354-356. AE(*N*)

_____(1960), "Hybrid Corn and the Economics of Innovation," *Science,* 132:275-280. AE(*E*)

_____(1962), "Profitability Versus Interaction:Another False Dichotomy," *Rural Sociology,* 27:325-330. AE(*N*)

_____(1980), "Hybrid Corn Revisited: A Reply," *Econometrika,* 48: 1463-1465. GE(*N*)

Gross, Neal C. (1942), *The Diffusion of a Culture Trait in Two Iowa Townships,* M.S. Thesis, Ames, Iowa State College. RS(*E*)

Gross, Neal, et al (1971), *Implementing Organizational Innovations: A Sociological Analysis of Planned Educational Change,* New York, Basic Books. E(*E*)

Grunig, James L. (1971), "Communication and the Economic Decision-Making Processes of Colombian Peasants," *Economic Development and Cultural Change,* 19:580-597. *C(E)*

Guimarães, Lytton L. (1968), *Matrix Multiplication in the Study of Interpersonal Communication,* M.A. Thesis, East Lansing, Michigan State University, Department of Communication. *C(E)*

_____(1972), *Communication Integration in Modern and Traditional Social Systems: A Comparative Analysis across Twenty Communities of Minas Gerais, Brazil,* Ph.D. Thesis, East Lansing, Michigan State University. C(*E*)

Hage, Jerald, and Robert Dewar, (1973), "Elite Values Versus Organizational Structure in Predicting Innovation,"

Administrative Science Quarterly, 18:279-290. GS(*E*)

Hägerstrand, Torsten (1952), *The Propagation of Innovation Waves,* Lund, Sweden, Lund Studies in Geography 4. *G(E)*

_____(1953), *Innovations for Loppet Ur Korologisk Synpunkt* (Innovation Diffusion as a Spatial Process), Lund, Sweden, University of Lund, Department of Geography Bulletin 15, and University of Chicago Press (1969). *G(E)*

_(1965), "A Monte Carlo Approach to Diffusion,'' *European Journal of Sociology,* 6:43-67. *G(N)*

_(1969), *Innovation Diffusion as a Spatial Process,* Chicago and London, University of Chicago Press.

Hahn, Carole Louise (1974), *Relationships between Potential Adopters' Perceptions of Social Studies Innovations and Their Adoption of These Innovations in Indiana, Ohio, Georgia, and Florida,* Ph.D. Thesis, Bloomington, Indiana University. *E(E)*

Hall, Gene E. (1974), *The Concerns-based Adoption Model: A Developmental Conceptualization of the Adoption Process within Educational Institutions,* Austin, University of Texas at Austin, Research and Development Center for Teacher Education. *E(N)*

Hall, Gene E., and Susan F. Loucks (1978), *Innovation Configurations: Analyzing the Adaptations of Innovations,* Austin, University of Texas, Research and Development Center for Teacher Education. *E(E)*

Hamblin, Robert L., et al (1973), *A Mathematical Theory of Social Change,* New York, Wiley. GS(*E*)

_____(1979), "Modeling Use Diffusion," *Social Forces,* 57:799-811. GS(*E*)

Hanneman, Gerhard J. (1969), *Computer Simulation of Information Diffusion in a Peasant Community,* M. A. Thesis, East Lansing, Michigan State University. *C(E)*

_(1971), "Simulating Diffusion Process," *Simulation and Games,* 387-404. C(*E*)

Hanneman, Gerhard J., and Greenberg, Bradley S. (1973), "Relevance and Diffusion of News of Major and Minor Events," *Journalism Quarterly,* 50:433-437. C(*E*)

Harding, Joe, et al (1973), *Population Council Copper-T Study Korea, Summary Report,* Berkeley, California, The 21C Corporation, Policy Research and Planning Group. A(*E*)

Harris, Jack S. (1940), "The White Knife Shoshoni of Nevada," in Ralph Linton (ed.), *The Acculturation of Seven American Indian Tribes,* New York, Appleton-Century-Crofts. A *(N)*

Hassinger, Edward (1959), "Stages in the Adoption Process," *Rural Sociology,* 24:52-53. RS(*N*)

Hauser, Philip M. (1967), "Family Planning and Population Programs: A Book Review Article," *Demography,* 4:397-414. GS(*N*)

Havelock, Ronald G. (1969), *Planning for Innovation,* Ann Arbor, University of Michigan, Institute for Social Research. *E(E)*

_____(1972), "The Role of Research Communities in National Problem Solving,'' Paper presented at the Institute of Electrical and Electronics Engineers. E(*E*)

_(1974), "Locals Say Innovation Is Local: A National Survey of School Superintendents," in Sanford Temkin and Mary V. Brown (eds.), *What Do Research Findings Say about Getting Innovations into Schools: A Symposium,* Philadelphia, Research for Better Schools. *E(E)*

Havelock, Ronald G., et al (1969), *Planning for Innovation through Dissemination and Utilization of Know/edge,* Ann Arbor, University of Michigan, Institute for Social Research, Center for Research on the Utilization of Scientific Knowledge. E(*N*)

_____(1974), *Educational Innovation in the United States, Vol. II, Five Case Studies of Educational Innovation at the School District Level,* Ann Arbor, University of Michigan, Center for Research on Utilization of Scientific Knowledge, Report. *E(E)*

Havens, A. Eugene (1975), "Diffusion of New Seed Varieties and Its Consequences: A Colombian Case," in Raymond E. Dumett and Lawrence J. Brainard (eds.), *Problems of Rural Development: Case Studies and Multi-Disciplinary Perspectives,* Leiden, E. J. Brill. RS(*E*)

Havens, A. Eugene, and Everett M. Rogers (1961), "Adoption of Hybrid Corn: Profitability and the Interaction *Effect," Rural Sociology,* 26:409-414. RS(*E*)

_(1961), "A Campaign That Failed: A Reason Why," Paper presented at Ohio Valley Sociological Society, Cleveland, Ohio. RS(*E*)

Hawley, Florence (1946), "The Role of Pueblo Social Organization in the Dissemination of Catholicism," *American Anthropologist,* 48:407-415.

Hayward, George, et al (1977), "Innovation Profiles: A New Tool for Capital Equipment Manufactures," *European Journal of Marketing,* 11:299-311. MR(*E*)

Herzog, William A., Jr. (1973), "Literacy and Community Development in Rural Brazil," *Rural Sociology,* 38:325-337. C(*E*)

Herzog, William, et al (1968), *Patterns of Diffusion in Rural Brazil,* East Lansing, Michigan State University, Department of Communication, Diffusion of Innovations Research Report 10. *C(E)*

Hightower, James (1972), *Hard Tomatoes, Hard Times: The Failure of America's Land-Grant College Complex,* Cambridge, Massachusetts, Schenkman.

Hill, Christopher, and James M. Utterback (1979), "The Dynamics of Product and Process Innovation," *Management Review,* 69:14-20. MR(*N*)

_____(1979), *The Technological Innovation for Dynamic Economy,* New York, Pergamon Press. MR(*N*)

Hochbaum, Godfrey M. (1958), *Public Participation in Medical Screening Programs: A Socio-Psychological Study,* Washington, D.C., U.S. Public Health Service, Bureau of State Services. P(*E*)

Holloway, Robert E. (1977), *Perceptions of an Innovation: Syracuse University Project Advance,* Ph.D. Thesis, Syracuse, New York, Syracuse University. *E(E)*

Hong, Sawon (1976), *Fertility and Fertility Limitation in Korean Villages: Community and Individual Level Effects,* Ph.D. Thesis, Honolulu, Hawaii, University of Hawaii. GS(*E*)

Hursh, Gerald D., et al (1969), *Innovation in Eastern Nigeria: Success and Failure of Agricultural Programs in 71 Villages,* East Lansing, Michigan State University, Department of Communication, Diffusion of Innovations Research Report 8. C(*E*)

Isenson, Raymond S. (1969), "Project Hindsight: An Empirical Study of the Sources of Ideas Utilized in Operational Weapon System," in William Gruber and Donald G. Marquis (eds.), *Factors in the Transfer of Technology,* Cambridge, Massachusetts, MIT Press.

Jewkes, John, et al (1969), *The Sources of Invention,* 2nd ed., New York, Norton.

Johnson, Bonnie, and Larry Browning (1979), "Extended Relationships: It's Who You Know That Counts," Paper

presented at the International Communication Association, Philadelphia.

Johnson, Donald E., and A. W. van den Ban (1959), "The Dynamics of Farm Practice Change," Paper presented at the Midwest Sociological Society, Lincoln, Nebraska. RS(*E*)

Johnson-Lenz, Peter, and Trudy Johnson-Lenz (1979), "Legitech/EIES: Information-Exchange and Collective Knowledge-Building among State Legislative Researchers," in Madeline M. Henderson and Marcia J. MacNaughton (eds.), *Electronic Communication: Technology and Impacts,* Boulder, Colorado, Westview Press.

Kaluzny, Arnold D., et al (1973), "Predicting Two Types of Program Innovation from Organizational Characteristics: The Case of Hospitals," Unpublished Paper. PH(*E*)

Kaluzny, Arnold D., and James E. Veney (1974), "Attributes of Health Services as Factors in Program Implementation," *Journal of Health and Social Behavior.* MS(*E*)

Kaplan, Abraham (1964), *The Conduct of Inquiry,* San Francisco, Chandler.

Katz, Elihu (1956), *Interpersonal Relations and Mass Communications: Studies in the Flow of Influence,* Ph.D. Thesis, New York, Columbia University. GS(*E*)

_____(1957), "The Two-Step Flow of Communication: An Up-to-Date Report on an Hypothesis," *Public Opinion Quarterly,* 21:61-78. GS(*E*)

_____(1961), "The Social Itinerary of Technical Change: Two Studies on the Diffusion of Innovation," in Wilbur Schramm (ed.), *Studies of Innovation and of Communication to the Public,* Stanford, California, Stanford University, Institute for Communication Research, and (1962), *Human Organization,* 20:70-82. GS(*E*)

Katz, Elihu, et al (1963), "Traditions of Research on the Diffusion of Innovations," *American Sociological Review,* 28:237-253. GS(*N*)

Katz, Elihu, and Paul F. Lazarsfeld (1955), *Personal Influence: The Part Played by People in the Flow of Mass Communications,* New York, Free Press.

Katzman, Natan (1974), "The Impact of Communication Technology: Promises and Prospects," *Journal of Communication,* 24:47-58. C(*N*)

Keith, Robert F. (1968), *An Investigation of Information and Modernization among Eastern Nigerian Farmers,* East Lansing, Michigan State University, Department of Communication, Technical Report 4. C(*E*)

Kervasdoue, Jean, and John R. Kimberly (1978), "Hospital Innovation in France and the United States: Organizational versus Institutional Explanations," New Haven, Connecticut, Yale University, School of Organization and Management, Report. MR *(E)*

Kimberly, John R. (1979A), "Hospital Adoption of Innovation: The Role of Integration into External Informational Environments," *Journal of Health and Social Behavior,* 19:361-373. MR(*E*)

_____(1981), "Managerial Innovation," in P.C. Nystrom and W. H. Starbuck (eds.), *Handbook in Organizational Design,* New York, Oxford University Press. MR(*N*)

Kimberly, John R., and Michael J. Evanisko (1981), "Organizational Innovation: The Influence of Individual, Organizational, and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations," *Academy of Management Journal,* 24:689-713. MR(*E*)

Kivlin, Joseph E. (1960), *Characteristics of Farm Practices Associated with Rate of Adoption,* Ph.D. Thesis, University Park, Pennsylvania State University. RS(*E*)

Kivlin, Joseph E., and Frederick C. Fliegel (1967), "Differential Perceptions of Innovations and Rate of Adoption," *Rural Sociology,* 32:78-91. RS(*E*)

_____(1967), "Orientations to Agriculture: A Factor Analysis of Farmers' Perceptions of New Practices," *Rural Sociology,* 33:127-140. *C(E)*

Klein, Josephine (1961), *Working with Croups: The Social Psychology of Discussion and Decision,* London, Hutchinson.

Klonglan, Gerald E. (1962), *Message Sharpening in a Multi-Step Communication Situation,* M. S. Thesis, Ames, Iowa State University. RS(*E*)

_____(1963), *Role of a Free Sample Offer in the Adoption of a Technological Innovation,* Ph.D. Thesis, Ames, Iowa State University. RS(*E*)

Klonglan, Gerald E., et al (1960), "The Role of a Free Sample in the Adoption Process," Paper presented at the Midwest Sociological Society, St. Louis, Missouri. RS(*E*)

_____(1960), "The Secondary Impact of a Free Sample Coupon Promotional Technique," Ames, Iowa State University, Department of Economics and Sociology, Rural Sociology Report 11. RS(*N*)

_____(1963) "Message Sharpening in a Multi-Step Communication Situation," Paper presented at the Rural Sociological Society, Northridge, California. RS(*E*)

Kohl, John W. (1966), *Adoption Stages and Perceptions of Characteristics of Educational Innovations,* Ed.D. Thesis, Eugene, University of Oregon.

Koontz, Virginia Lansdon (1976), *Determinants of Individuals' Levels of Knowledge, Attitudes Towards, and Decisions Regarding a Health Innovation in Maine,* Ph.D. Thesis, Ann Arbor, University of Michigan. PS(*E*)

Korsching, Peter F., et al (1981), "A Comparison of Adopters of Conservation Practices with Traditional Innovation Adopter Categories," Paper presented at the Rural Sociological Society, Guelph, Canada. *RS(E)*

Kotler, Philip, and Gerald Zaltman (1971), "Social Marketing: An Approach to Planned Social Change," *Journal of Marketing,* 35:3-12.

Kozma, Robert B. (1978), "Faculty Development and the Adoption and Diffusion of Classroom Innovations," *Journal of Higher Education,* 49:438-449. *E(E)*

_____(1979), "Communication, Rewards and the Use of Classroom Innovations," *Journal of Higher Education,* 50:761-771. *E(E)*

Kroeber, A. L. (1923), *Anthropology,* New York, Harcourt, Brace. *A(E)*

_____(1937), "Diffusion," in Edwin R. A. Seligman and Alvin Johnson (eds.), *The Encyclopedia of the Social Sciences, II,* New York, Macmillan. A(*N*)

Kuhn, Thomas S. (1970), *The Structure of Scientific Revolutions,* University of Chicago Press.

Kunkel, John H. (1977), "The Behavioral Perspective of Social Dynamics," in Robert L. Hamblin and John H. Kunkel (eds.), *Behavioral Theory in Sociology,* New Brunswick, New Jersey, Transaction.

LaMar, Ronald V. (1966), *In-Service Education Needs Related to the Diffusion of an Innovation,* Ph.D. Thesis, Berkeley, University of California. *E(E)*

Lambright, W. Henry (1980), "Decision-Making for Urban Technology," *Policy Sciences,* 11:329-341. PS(*E*)

Lambright, W. Henry, and Paul J. Flynn (1977), "Bureaucratic Politics and Technological Change in Local Government," *Urban Analysis,* 4:93-118. PS(*E*)

Langlois, Simon (1977), "Les Réseaux Personnels et la Diffusion des Informations sur les Emplois," *Recherches Sociographiques,* 2:213-245.

La Piere, Richard T. (1965), *Social Change,* New York, McGraw-Hill.

Larsen, Judith K. (1982), *Information Utilization,* Palo Alto, California, American Institutes for Research, Report.

Larsen, Judith K., and Rekha Agarwala-Rogers (1977), *Re-Invention in Adoption: A Study of Community Health Centers,* Palo Alto, California, American Institutes for Research in the Behavioral Sciences, Report. P(*E*)

_____(1977), "Re-Invention of Innovative Ideas: Modified? Adopted? None of the Above?" *Evaluation,* 4:136-140. C(*E*)

Lazarsfeld, Paul F. and Herbert Menzel, (1963), "Mass Media and Personal Influence," in Wilbur Schramm (ed.), *The Science of Human Communication,* New York, Basic Books.

Lazarsfeld, Paul F., and Robert K. Merton (1964), "Friendship as Social Process: A Substantive and Methodological Analysis," in Monroe Berger and others (eds.), *Freedom and Control in Modern Society,* New York, Octagon.

Lazarsfeld, Paul F., et al (1944), *The People's Choice,* New York, Duell, Sloan, and Pearce.

Lee, Sea Baick (1977), *System Effects on Family Planning Behavior in Korean Villages,* Ph.D. Thesis, Ann Arbor, University of Michigan. MS(*E*)

Leonard-Barton, Dorothy (1981), "The Diffusion of Active Residential Solar Energy Equipment in California," in Avraham Shama (ed.), *Marketing Solar Energy Innovations,* New York, Praeger. MR(*E*)

Leonard-Barton, Dorothy, and Everett M. Rogers (1980), "Voluntary Simplicity: Precursor or Fad?" Paper presented at the American Association for the Advancement of Science, San Francisco. C(*E*)

Leonard-Barton, Dorothy, et al (1980), *The Potential Market for Solar Equipment among California Homeowners,* Stanford, California, Stanford University, Institute for Communication Research, Report to the California Energy Commission. *C(E)*

Leonard-Barton, Dorothy, and Everett M. Rogers (1981), "Horizontal Diffusion of Innovations: An Alternative Paradigm to the Classical Diffusion Model," Cambridge, Massachusetts Institute of Technology, Alfred P. Sloan School of Management, WP 1214-81. *C(N)*

Lessley, Bradley J. (1980), *The Dvorak Keyboard,* Salem, Oregon, Dvorak International Federation, Report.

Leuthold, Frank O. (1965), *Communication and Diffusion of Improved Farm Practices in Two Northern Saskatchewan Farm Communities,* Saskatoon, Saskatchewan, Centre for Community Studies, Mimeo Report.

(1967), *Discontinuance of Improved Farm Innovations by Wisconsin Farm Operators,* Ph.D. Thesis, Madison, University of Wisconsin. RS(*E*)

Lin, Nan (1966), *Innovation Internalization in a Formal Organization,* Ph.D. Thesis, East Lansing, Michigan State University. *C(E)*

Lin, Nan, et al (1966), *The Diffusion of an Innovation in Three Michigan High Schools: Institution Building through Change,* East Lansing, Michigan State University, Project on the Diffusion of Educational Practices in Thailand, Research Report 1. E(*E*)

_(1981), "Social Resources and Strength of Ties: Structural Factors in Occupational Status Attainment," *American Sociological Review,* 46: 393-405.

Linton, Ralph (1936), *The Study of Man,* New York, Appleton-Century-Crofts. A(*N*)

Linton, Ralph and Abram Kardiner (1952), "The Change from Dry to Wet Rice Cultivation in Tanala-Betsileo," in Guy E. Swanson et al (eds.), *Readings in Social Psychology,* New York, Henry Holt. A(*E*)

Lionberger, Herbert F., and H. C. Chang (1970), *Farm Information for Modernizing Agriculture: The Taiwan System,* New York, Praeger. RS(*E*)

Liu, William T., and Duff, Robert W. (1972), "The Strength of Weak Ties," *Public Opinion Quarterly,* 36:361-366. GS(*E*)

Lockeretz, William, et al (1981), "Organic Farming in the Corn Belt," *Science,* 211:540–547. U(*E*)

Lockeretz, William, and Sarah Wernick (1980), "Commercial Organic Farming in the Corn Belt in Comparison to Conventional Practices," *Rural Sociology,* 45:708-722. RS(*E*)

Louis, Karen Seashore (1977), "Dissemination of Information from Centralized Bureaucracies to Local Schools: The Role of the Linking Agent," *Human Relations,* 30:25-42. GS(*E*)

Lowe, Charles U. (1980), "The Consensus Development Programme: Technology Assessment at the National Institute of Health," *British Medical Journal,* 1583-1584.

_____(1981), *Biomedical Discoveries Adopted by Industry for Purposes Other than Health Services,* Washington, D.G., National Institutes of Health, Office of Medical Applications of Research, Report.

Machiavelli, Nicoló (1513), *The Prince,* trans. by George Bull, Baltimore, Penguin Books, 1961.

Magill, Kathleen P., et al (1981), *Improving the Diffusion of Mass Transportation Innovations,* Stanford, California, Stanford University, Institute for Communication Research, Report. C(*E*)

Magill, Kathleen P., and Everett M. Rogers (1981), "Federally Sponsored Demonstrations of Technological Innovations," *Knowledge,* 3:23-42. C *(E)*

Manning, Phil R., and Teri A. Danson (1980), "How Internists Learned about Cimetidine," *Annals of Internal Medicine,* 92:690-692. MS(*E*)

Mansfield, Edwin (1961), "Technical Change and the Rate of Imitation," *Econometrica,* 29:741-766. GE(*E*)

_(1963), "Size of Firm, Market Structure, and Innovation," *Journal of Political Economy,* 71:556-576. GE(*E*)

_(1971), *Research and Innovation in the Modern Corporation,* New York, Norton. GE(*E*)

– (1972), "Contribution of Rand D to Economic Growth in the United States," *Science,* 175:477–485. GE(*N*)

March, James G. (1981), "Footnotes to Organizational Change," *Administrative Science Quarterly,* 26:563-577.

Marr, Rainer (1973), *Innovation und Kreativitat: Planung und Gestaltung Industrieller Forschung und Entwicklung,* Wiesbaden, Germany, Betriebswirtshafticker Verlag. MR(*N*)

Marting, Elizabeth (1964), *New Products, New Profits,* New York, American Management Association. MR(*N*)

Mason, Robert G. (1962), *Information Source Use in the Adoption Process,* Ph.D. Thesis, Stanford, California, Stanford University. C(*E*)

_(1962), "An Ordinal Scale for Measuring the Adoption Process," in Wilbur Schramm (ed.), *Studies of Innovation and of Communication to the Public,* Stanford, California, Stanford University, Institute for Communication Research. *C(E)*

_(1963), "The Use of Information Sources by Influentials in the Adoption Process," *Public Opinion Quarterly,* 27:455-457. C(*E*)

_(1964), "The Use of Information Sources in the Process of Adoption," *Rural Sociology,* 29:40-52.

(1966), "Information Sources and the Adoption of Innovations," *Gazette,* 12:112-116. EX(*N*)

_____(1966), "A Revision of the Two-Step Flow of Communication Hypothesis,'' *Gazette,* 12:109–111. EX *(N)*

Mason, Robert, and Albert N. Halter (1968), "The Application of a System of Simultaneous Equations to an Innovation Diffusion Model," *Social Forces,* 47:182-195. *C(E)*

_____(1980), "Risk Attitude and the Forced Discontinuance of Agricultural Practices," *Rural Sociology,* 45:435-447. RS(*E*)

Marx, Karl (1906), *Capital,* Vol. I, New York, Random House.

McLuhan, Marshall (1964), *Understanding Media: The Extensions of Man,* New York, McGraw-Hill.

McNelly, John T., and J. R. Molina (1972), "Communication, Stratification, and International Affairs Information in a Developing Society," *Journalism Quarterly,* 49:316-326, 339.

Mendez, Alfredo D. (1968), "Social Structure and the Diffusion of Innovation," *Human Organization,* 27:241-249. A(*E*)

Menzel, Herbert (1957), "Public and Private Conformity under Different Conditions of Acceptance in the Group," *Journal of Abnormal and Social Psychology,* 55:398-402. MS *(E)*

_____(1959), *Social Determinants of Physicians' Reactions to Innovations in Medical Practice,* Ph.D. Thesis, Madison, University of Wisconsin, MS(*E*)

_____(1960), "Innovation, Integration, and Marginality: A Survey of Physicians," *American Sociological Review,* 25:704-713. MS(*E*)

Menzel, Herbert, and Elihu Katz (1955), "Social Relations and Innovation in the Medical Profession: The Epidemiology of a New Drug," *Public Opinion Quarterly,* 19:337-352. MS(*E*)

Menzel, Herbert, et al (1959), "Dimensions of Being 'Modern' in Medical Practice," *Journal of Chronic Diseases,* 4:20-40. MS(*E*)

Merton, Robert K. (1968), *Social Theory and Social Structure,* New York, Free Press.

Midgley, David F. (1977), *Innovation and New Product Marketing,* London, England, Croom Helm. MR(*E*)

Midgley, David F., and Grahame Dowling (1978), "Innovativeness: The Concept and Its Measurement," *Journal of Consumer Research,* 4:229-242. MR(*N*)

Miles, Matthew B. (ed.) (1964), *Innovation in Education,* New York, Columbia University, Teachers College. E(*N*)

Miller, Gerald R., and Michael Burgoon (1978), "Persuasion Research: Review and Commentary," in Brent D. Rubin (ed.), *Communication Yearbook 2,* New Brunswick, New Jersey, Transaction.

Moch, Michael K., and Edward V. Morse (1977), "Size, Centralization and Organizational Adoption of Innovations," *American Sociological Review,* 42:716-725. GS(*E*)

Mohr, Lawrence B. (1966), *Determinants of Innovation in Organizations,* Ph.D. Thesis, Ann Arbor, University of Michigan. PS(*E*)

_____(1969), "Determinants of Innovation in Organizations," *American Political Science Review,* 63:111-126. PS(*E*)

_____(1978), "Process Theory and Variance Theory in Innovation Research," in Michael Radnor et al (eds.), *The Diffusion of Innovations: An Assessment,* Evanston, Illinois, Northwestern University, Center for Interdisciplinary Study of Science and Technology, Report to the National Science Foundation. PS(*N*)

Moore, WilbertE. (1963), *Social Change,* Englewood Cliffs, N. J., Prentice-Hall.

Morrison, Denton E., et al (1976), "Stratification and Risk Taking: A Further Negative Replication of Cancian's Theory (Comment on Cancian, ASR, December, 1967),'' *American Sociological Review.* RS(*E*)

Mort, Paul R. (1953), "Educational Adaptability," *The School Executive,* 71:1-23. E(*E*)

Mosteller, Frederick (1981), "Innovation and Evaluation," *Science,* 211: 881-886. *S(N)*

Mueller, D. C., and J. E. Tilton (1969), "Research and Development Costs as a Barrier to Entry,'' *Canadian Journal of Economics,* 2:570-579.

Murray, Stephen O. et al (1981), "Strong Ties and Job Information," *Sociology of Work and Occupations,* 8:119–136.

Myers, Sumner (1978), *The Demonstration Project as a Procedure for Accelerating the Application of New Technology,* Washington, D.C., Institute of Public Administration, Report.

Mytinger, Robert E. (1968), *Innovation in Local Health Services: A Study of the Adoption of New Programs by Local Health Departments with Particular Reference to New Health Practices, Washington, D.C.,* U.S. Department of Health, Education and Welfare, Public Health Service, Division of Medical Care Administration. PH(*E*)

Nader, Ralph (1965), *Unsafe at Any Speed,* New York, Grossman.

Nelkin, Dorothy (1973), *Methodone Maintenance: A Technological Fix,* New York, George Braziller.

Niehoff, Arthur (1964), *The Primary Variables in Directed Cross-Cultural Change,* Alexandria, Virginia, George Washington University, Human Resources Research Office. A(*N*)

_____(1964), ''Theravada Buddhism: A Vehicle for Technical Change," *Human Organization,* 23:108-112.

_(1966), *A Casebook of Social Change,* Chicago, Aldine. A(*N*)

Office of Technology Assessment (1981), *Policy Implications of the Computed Tomography <CT) Scanner: An Update,* Washington, D.C., Office of Technology Assessment, Report.

Olshavsky, Richard W. (1980), "Time and the Rate of Adoption of Innovations," *Journal of Consumer Research,* 6:425-428. MR(*E*)

Ostlund, Lyman E. (1974), "Perceived Innovation Attributes as Predictors of Innovativeness," *Journal of Consumer Research,* 1:23-29. MR(*E*)

O'Sullivan, Jeremiah Ryan (1978), "The Role of Information in the Life of the Subsistence Farmer: A Study of the Guatemalan Western Central Highland," Paper presented at the International Association for Adult Education, Mexico City. *C(E)*

Parkinson, Robert (1972), "The Dvorak Simplified Keyboard: Forty Years of Frustration," *Computers and Automation,* 21:1-8.

Paul, Benjamin D. (ed.) (1955), *Health, Culture, and Community: Case Studies of Public Reactions to Health Programs,* New York, Russell Sage Foundation. A(*E*)

Pelto, Pertti J. (1973), *The Snowmobile Revolution: Technology and Social Change in the Artie,* Menlo Park, California, Cummings Publishing Company. A(*E*)

Pelto, Pertti J., and Ludger Müller-Wille (1972), "Snowmobiles: Technological Revolution in the Arctic," in H. Russell Bernard and Pertti Pelto (eds.), *Technology and Social Change,* New York, Macmillan. A(*E*)

Pelto, Pertti J., et al (1969), "The Snowmobile Revolution in Lapland," *Journal of the Finno-ugrie Society,* 69:1–42. A(*E*)

Pelz, Donald C. (1981), ''Staging' Effects in Adoption of Urban Innovations," Paper presented at the Evaluation Research Society, Austin. P(*E*)

Pemberton, H. Earl (1936), "The Curve of Culture Diffusion Rate,'' *American Sociological Review,* 1:547-556. ES *(E)*

———(1936), "Culture-Diffusion Gradients," *American Journal of Sociology,* 42:226-233. ES(*E*)

_(1937), "The Effect of a Social Crisis on the Curve of Diffusion," *American Sociological Review,* 2:55-61. ES(*E*)

_(1938), "Spatial Order of Cultural Diffusion,'' *Sociology and Social Research,* 22:246-251. ES(*E*)

Perry, James L., and James N. Danziger (1980), "The Adoptability of Innovations: An Empirical Assessment of Computer Applications in Local Governments," *Administration and Society,* 11:461-492. MR(*E*)

Petrini, Frank (1966), *Upplysningsverksamhetes Effekt 1. Innovationernas Spridningstakt* (The Rate of Adoption of Selected Agricultural Innovations), Uppsala, Lantbruks-Hogskolans Meddelanden (Agricultural College of Sweden), Report 53. RS(*E*)

Petrini, Frank, et al (1968), *The Information Problem of an Agricultural College,* Uppsala, Sweden, Nordisk Jordbrukforskning 50. RS(*E*)

Pitcher, Brian L., et al (1978), "The Diffusion of Collective Violence," *American Sociological Review,* 43:23-35.

Pitts, Forrest R. (1967), *M1FCAL and NONCEL: Two Computer Programs for the Generalization of the Hägerstrand Models to an Irregular Lattice,* Evanston, Illinois, Northwestern University, Department of Geography, Technical Report 7. G(*N*)

Placek, Paul J. (1975), "Welfare Workers as Family Planning Change Agents and the Perennial Problem of Heterophily with Welfare Clients," *Applied Behavioral Science,* 2:298-316.

Pope, Alexander (1711), *An Essay on Criticism,* Part II.

Pred, Allan R. (1977), "The Choreography of Existence: Comments on Hägerstrand's Time-Geography and Its Usefulness," *Economic Geography,* 53:207-221. G(*N*)

———(1978), "The Impact of Technological and Institutional Innovations on Life Content: Some Time-Geographic Observations," *Geographical Analysis,* 10:345-372. *G(E)*

de Solla Price, Derek J. (1963), *Little Science, Big Science,* New York, Columbia University Press.

Rahim, S. A. (1961), *The Diffusion and Adoption of Agricultural Practices: A Study in a Village in East Pakistan,* Comilla, Pakistan Academy for Village Development. *C(E)*

———(1965), "Communication and Personal Influence in an East Pakistan Village," Comilla, East Pakistan Academy for Rural Development, Research and Survey Bulletin. C *(E)*

Rao, G. Appa, and Everett M. Rogers (1980), "Caste and Formal Education in Interpersonal Diffusion of an Innovation in Two Indian Villages," *Indian Journal of Extension Education,* 16:1-9. *EX(E)*

Rao, G. Appa, and S. N. Singh (1980a), "Structural and Functional Analysis of Interpersonal Communication Networks in Diffusion of High Yielding Rice Varieties in Two Villages," *Oryza,* 17:218-222. *EX(E)*

———(1980b), "Farmers' Characteristics and Adoption of High Yielding Rice Varieties in Two Villages," *Oryza,* 17:223-227. *EX(E)*

———(1981), "Profile of Communication in Innovative and Non-Innovative Villages," *Oryza,* 18:93-97. *EX(E)*

Rao, G. Appa, et al (1980), "Interpersonal Relations in the Diffusion of an Innovation in Two Indian Villages," *Indian Journal of Extension Education,* 16:19-24. *EX(E)*

Rapoport, J. (1978), "Diffusion of Technological Innovation among Non-Profit Firms: A Case Study of

Radioisotopes in U.S. Hospitals," *Journal of Economic Business,* 301:108. MS(*E*)

Rasmussen, Wayne D. (1968), "Advances in American Agriculture: The Mechanical Tomato Harvester as a Case Study,'' *Technology and Culture,* 9:531-543.

Reardon, Kathleen Kelley (1981), *Persuasion: Theory and Context,* Beverly Hills, California, Sage.

Repetto, Robert (1969), "India: A Case Study of the Madras Vasectomy Program," *Studies in Family Planning,* 31:8-16. GE(*E*)

———(1977), "Correlates of Field-Worker Performance in the Indonesian Family Planning Program: A Test of the Homophily-Hetrophily Hypothesis," *Studies in Family Planning,* 8:19-21. PH(*E*)

Rice, E. B. (1974), *Extension in the Andes,* Cambridge, Massachusetts, MIT Press.

Rice, Ronald E., and Everett M. Rogers (1980), "Re-Invention in the Innovation Process," *Knowledge,* 1:499–514. *C(E)*

Robertson, Thomas S. (1971), *Innovative Behavior and Communication,* New York; Holt, Rinehart and Winston. MR(*N*)

Robertson, Thomas S., and Yoram Wind (1980), "Organizational Psychographics and Innovativeness," *Journal of Consumer Research,* 7:24–31. MR(*E*)

Roessner, J. David (1977), "Incentives to Innovate in Public and Private Organizations," *Administration and Society,* 9:341-365. PS(*N*)

Rogers, Everett M. (1958), "A Conceptual Variable Analysis of Technological Change,'' *Rural Sociology,* 23:136–145. RS(*E*)

———(1961), *Characteristics of Agricultural Innovators and Other Adopter Categories,* Wooster, Ohio, Agricultural Experiment Station Research Bulletin 882. RS(*E*)

_(1962), *Diffusion of Innovations,* New York, Free Press of Glencoe, RS(*N*)

_(1973), *Communication Strategies for Family Planning,* New York, Free Press. *C(N)*

———(1976), "Communication and Development: The Passing of the Dominant Paradigm" *Communication Research,* 3:121-148.

———(1977), "Re-Invention of New Ideas During the Innovation Process in Public Organizations," in W. Henry Lambright and James Carroll (eds.), *Proceedings of a Conference on Technology Transfer to Urban Governments: Agenda for Research and Education,* Syracuse University, Maxwell School of Citizenship and Public Affairs. *C(E)*

———(1978), "Re-Invention During the Innovation Process," in Michael Radnor et al (eds.), *The Diffusion of Innovations: An Assessment,* Evanston, Illinois, Northwestern University, Center for the Interdisciplinary Study of Science and Technology, Report to the National Science Foundation. *C(N)*

———(1980), ''Barefoot Doctors,'' in George Lythscott (ed.), *Rural Health in the People's Republic of China,* Washington, D.C., Department of Health and Human Services, Foggarty Center for International Health. *C(E)*

———(1981a), "The Empirical and the Critical Schools of Communication Research," in Michael Burgoon (ed.), *Communication Yearbook 5,* New Brunswick, New Jersey, Transaction.

_(1981b), "Methodology for Meta-Research,'' Paper presented at the International Communication Association, Minneapolis.

———(1981c), "Diffusion of Innovations: An Overview," in Edward B.

Roberts et al (eds.), *Biomedical Innovation,* Cambridge, Massachusetts, MIT Press. C(*N*)

_(1981d), "The Transfer of Information from Researcher to Consumer," Paper presented at the Solar Energy Information Symposium, Denver. C(*E*)

_(1982), *Introduction to Diffusion Science: An Interdisciplinary, Cross-Cultural Approach through Communication Sciences to the Study of the Diffusion of Innovations,* trans. Yoshiyasu Uno, Tokyo, Japan, Sangyo Noritsu Press. C(*N*)

Rogers, Everett M., and Ronny Adhikarya (1979), "Diffusion of Innovations: An Up-to-Date Review and Commentary," in Dan Nimmo (ed.), *Communication Yearbook 3,* New Brunswick, New Jersey, Transaction. *C(N)*

Rogers, Everett M., and Rekha Agarwala-Rogers (eds.) (1975), *Evaluation Research on Family Planning Communication,* Paris, UNESCO, Population Communication: Technical Documentation 4.C(*N*)

_____(1976), *Communication in Organizations,* New York, Free Press. C(*N*)

Rogers, Everett M., and Rabel J. Burdge (1962), *Community Norms, Opinion Leadership, and Innovativeness among Truck Growers,* Wooster, Ohio Agricultural Experiment Station Research Bulletin 912. RS(*E*)

Rogers, Everett M., and Pi-Chao Chen (1980), "Diffusion of Health and Birth Planning Innovations in the People's Republic of China," in George I. Lythscott et al (eds.), *Report of the Chinese Rural Health Delegation,* Washington, D.C., U.S. Department of Health and Human Services, Fogerty Center for International Health, Report. *C(E)*

Rogers, Everett M., and A. Eugene Havens (1962), "Predicting Innovativeness," *Sociological Inquiry,* 32:34-42. RS(*E*)

_____(1962), "Rejoinder to Griliches' 'Another False Dichotomy'," *Rural Sociology,* 27:330-332. RS(*N*)

Rogers, Everett M., and Joung-Im Kim (1981), "The Diffusion of Innovations in Public Organizations," in Richard L. Merritt (ed.), *Handbook on the Comparative Study of Innovation. C(N)*

Rogers, Everett M., and D. Lawrence Kincaid (1981), *Communication Networks: Toward a New Paradigm for Research,* New York, Free Press.

Rogers, Everett M., and Dorothy Leonard-Barton (1978), "Testing Social Theories in Marketing Settings," *American Behavioral Scientist,* 21: 479-500. *C(N)*

Rogers, Everett M., and Wicky L. Meynen (1965), "Communication Sources for 2,4–D Weed Spray among Colombian Peasants," *Rural Sociology,* 30:213-219. *C(E)*

Rogers, Everett M. et al (1970), *Diffusion of Innovations in Brazil, Nigeria, and India,* East Lansing, Michigan State University, Department of Communication, Diffusion of Innovations Research Report 24. *C(E)*

_(1975), *Diffusion of Impact Innovations to University Professors: A Final Report to the Exxon Education Foundation,* Ann Arbor, Michigan, University of Michigan, Department of Journalism, Mimeo Report. *C(E)*

_(1976), "The Diffusion and Adoption of GBF/Dime among Regional and Local Governments," Paper presented at the Urban and Regional Information Systems Association, Atlanta. C(*E*)

_____(1977a), *The Innovation Process in Public Organizations,* Ann Arbor, University of Michigan, Department of Journalism, Report. *C(E)*

_____(1977b), *Bibliography of the Diffusion of Innovations,* Monticello, Illinois, Council of Planning Librarians. C(*N*)

_____(1979a), "Solar Diffusion in California: A Pilot Study," Stanford, California, Stanford University, Institute for Communication Research, Report. C(*E*)

_(1979b), "The Innovation Process for Dial-A-Ride," Stanford, California, Stanford University, Institute for Communication Research, Report. C(*E*)

_____(1980a), "Social and Cultural Influences on Poverty-Oriented Human Resource Development Policies and Programs," in Peter T. Knight (ed.), *Implementing Programs of Human Development,* Washington, D.C., World Bank, Staff Working Paper 403. C(*N*)

_(1980b), *Modeling Technological Innovation in Private Firms: The Solar and Microprocessor Industries in Northern California,* Stanford, California, Stanford University, Institute for Communication Research, Report.

_(1982a), *Extending the Agricultural Extension Model,* Washington, D.C., University Press of America. C(*N*)

_(1982b), "Japanese and U.S. Management: Quality of Production and Technological Innovation," in Franklin Weinstein and Therese Flaherty (eds.), *Japanese and U.S. Competition in the Semiconductor Industry,* Boulder, Colorado, Westview Press. *C(E)*

Rogers, Everett M., and Udai Pareek (1982), *Acceptability of Fertility Regulating Mechanisms: A Synthesis of Research Literature,* Stanford, California, Stanford University, Institute for Communication Research, Report to the World Health Organization. *C(N)*

Rogers, Everett M., and Johannes C. van Es (1964), *Opinion Leadership in Traditional and Modern Colombian Peasant Communities,* East Lansing, Michigan State University, Department of Communication, Diffusion of Innovations Research Report 2. RS(*E*)

Rogers, Everett M., with Floyd F. Shoemaker (1971), *Communication of Innovations: A Cross-Cultural Approach,* New York, Free Press. C(*E*)

Rogers, Everett M. with Lynne Svenning (1969), *Modernization among Peasants: The Impact of Communication,* New York, Holt, Rinehart and Winston. C(*E*)

Roling, Niels (1981), "Alternative Approaches in Extension," in Gwyn E. Jones and M. Rolls (eds.), *Progress in Rural Extension and Community Development,* Chichester, England, Wiley. EX(*N*)

Roling, Niels G., et al (1976), "The Diffusion of Innovations and the Issue of Equity in Rural Development," *Communication Research,* 3:155-170. C (*E*)

Rosengren, Karl E. (1973), "News Diffusion: An Overview," *Journalism Quarterly,* 50:83-91. GS(*E*)

Ross, Donald H. (1952), "Rate of Diffusion for Driver Education," *Safety Education,* 32:16-32. E(*E*)

_____(1958), *Administration for Adaptability: A Source Book Drawing Together the Results of More than 150 Individual Studies Related to the Question of Why and How Schools Improve,* New York, Metropolitan School Study Council. E(*N*)

Rothman, Jack (1974), *Planning and Organization for Social Change: Action Principles from Social Science Research,* New York, Columbia University Press. GS(*N*)

Roy, Prodipto (1967), *The Impact of Communications on Rural Development in India,* Hyderabad, National Institute of Community Development, Mimeo Report. RS(*E*)

Roy, Prodipto, et al (1968), *The Impact of Communication on Rural Development: An Investigation in India and Costa Rica,* Hyderabad, India, National Institute of Community Development. *C(E)*

Ryan, Bryce (1948), "A Study in Technological Diffusion," *Rural Sociology,* 13:273-285. RS(*E*)

Ryan, Bryce, and Neal C. Gross (1943), "The Diffusion of Hybrid Seed Corn in Two Iowa Communities," *Rural Sociology,* 8:15-24. RS(*E*)

_(1950), *Acceptance and Diffusion ofHybrid Corn Seed in Two Iowa Communities,* Ames, Iowa Agricultural Experiment Station Research Bulletin 372. RS(*E*)

Ryan, W. (1971), *Blaming the Victim,* New York, Pantheon.

Sahal, Devendra (1981), *Patterns of Technological Innovation,* Reading, Massachusetts, Addison-Wesley. GE *(E)*

Sapolsky, Harvey M. (1967), "Organizational Structure and Innovation," *Journal of Business,* 40:497-510.

Sawhney, Man Mohan (1966), "Farm Practice Adoption and the Use of Information Sources and Media in a Rural Community in India," Paper presented at the Rural Sociological Society, Miami Beach, Florida. RS(*E*)

Scannel, J. G., et al (1971), "Optimal Resources for Cardiac Surgery," *Circulation,* 221-236.

Schmidt, Peter (1976), *Innovation: Diffusion von Neuerungen im Sozialen Bereich,* Hamburg, Germany, Hoffman und Campe Verlag. GS(*N*)

Schmitz, Andrew, and David Seckler (1970), "Mechanized Agriculture and Social Welfare: The Case of the Tomato Harvester," *American Journal of Agricultural Economics,* 52:569-577.

Schón, Donald A. (1971), *Beyond the Stable State,* New York, Random House.

Schumacher, E. F. (1973), *Small Is Beautiful: Economics as if People Mattered,* New York, Harper and Row.

Schumpeter, Joseph A. (1950), *Capitalism, Socialism, and Democracy,* New York, Harper and Row.

Shah, I. (1968), Caravan ofDreams, Baltimore, Penguin Books.

Shama, Avraham (ed.) (1981), *Marketing Solar Energy Innovations,* New York, Praeger. MR(*E*)

Shannon, Claude E., and Warren Weaver (1949), *The Mathematical Theory of Communication,* Urbana, University of Illinois Press.

Sharp, Lauriston (1952), "Steel Axes for Stone Age Australians," in Edward H. Spicer (ed.), *Human Problems in Technological Change,* New York, Russell Sage Foundation. A(*E*)

Shell, Ruppe Ellen (1981), "CAT Fever: A Questionable Prognosis," *Technology Review,* 23-26.

Shingi, Prakash M., and Bella Mody (1976), "The Communication Effects Gap: A Field Experiment on Television and Agricultural Ignorance in India," *Communication Research,* 3: 171-193. MR(*E*)

Shingi, Prakash M., et al (1981), "Agricultural Technology and the Issue of Unequal Distribution of Rewards: An Indian Case Study," *Rural Sociology,* 46:430-445. RS(*E*)

Siebold, Davis R. (1979), "Criticisms of Communication Theory and Research: A Critical Celebration," *Central States Speech Journal,* 30:25-39.

Sill, Maurice L. (1958), *Personal, Situational, and Communicational Factors Associated with the Farm Practice Adoption Process,* Ph.D. Thesis, University Park, Pennsylvania State University. RS(*E*)

Silverman, Leslie J., and Wilfrid C. Bailey (1961), *Trends in the Adoption of Recommended Farm Practices,* State College, Mississippi Agricultural Experiment Station Bulletin 617.

Singh, B. N., and P. N. Jha (1965), "Utilization of Sources of Farm Information in Relation to Adoption of Improved Agricultural Practices," *Indian Journal of Extension Education,* 1:33-42. EX(*E*)

Singh, Ram M. (1966), *Characteristics of Farm Innovations Associated with the Rate of Adoption,* Guelph, Ontario Agricultural Extension Education Report 14. EX(*E*)

Singh, Y. P., and Udai Pareek (1968), "A Paradigm of Sequential Adoption," *Indian Educational Review,* 3:89-114. EX(*E*)

Sollie, Carlton, R. (1966), "A Comparison of Reputational Techniques for Identifying Community Leaders," *Rural Sociology,* 31:301-309

Spence, William Robert (1971), *Sociological Aspects of the Adoption of Innovations in Northern Ireland Farming Communities,* Ph.D. Thesis, Belfast, Ireland, Queen's University. RS(*E*)

Spicer, Edward H. (ed.) (1952), *Human Problems in Technological Change,* New York, Russell Sage Foundation. A(*E*)

Stevens, Chandler H. (1980), "Many-to-Many Communication Through Inquiry Networking," *World Future Society Bulletin,* 14:6.

Stone, John T. (1952), *How County Agricultural Agents Teach,* East Lansing, Michigan State University, Agricultural Extension Service, Mimeo Bulletin. RS(*E*)

Takeshita, John Y. (1964), "Taiwan: The Taichung Program of Prepregnancy Health," *Studies in Family Planning,* 4:10-12. MS(*E*)

_____(1966), "Lessons Learned from Family Planning Studies in Taiwan and Korea," in Bernard Berelson et al (eds.), *Family Planning and Population Programs,* Chicago, Illinois, University of Chicago Press. MS(*E*)

Takeshita, John Y., et al (1964), "A Study of the Effectiveness of the Prepregnancy Health Program in Taiwan," *Eugenics Quarterly,* 2:222-233.

Tarde, Gabriel (1903), *The Laws of Imitation,* New York, Holt, Trans. Elsie Clews Parsons. GS(*N*)

_____(1969), *On Communication and Social Influence,* Terry N. Clark (ed.), University of Chicago Press. GS(*N*)

Tehranian, Majid (1979), "Iran: Communication, Alienation, Revolution," *Intermedia,* 6-12.

Thomas, W. I. and Florian Znaniecki (1927), *The Polish Peasant in Europe and America,* New York, Knopf.

Thompson, James D. (1967), *Organizations in Action,* New York, McGraw-Hill.

Tichenor, Philip J., et al (1970), "Mass Media Flow and Differential Growth in Knowledge," *Public Opinion Quarterly,* 34:159-170.

Tornatzky, Louis G., and Katherine J. Klein (1981), *Innovation Characteristics and Innovation Adoption-Implementation: A Meta-Analysis of Findings,* Washington, D.C., National Science Foundation, Division of Industrial Science and Technological Innovation. P(*N*)

Tornatzky, Louis G., et al (1979), *Innovation Processes and Their Management: Conceptual, Empirical, and Policy Review of Innovation Process Research,* Washington, D.C., National Science Foundation, Division of Policy Research and Analysis, Draft Report.

_____(1980), *Innovation and Social Process,* New York, Pergamon Press.

Tucker, Carlos F. (1961), *Prediction of Rate ofAdoption from Characteristics of Farm Innovations,* M.S. Thesis, Columbus, Ohio State University.

U.S. Department of Agriculture (1980), *Report and Recommendations on Organic Farming,* Washington, D.C.,

U.S. Government Printing Office, Report.

U.S. General Accounting Office (1972), *Report to the Congress: The Forest Service Needs to Ensure that the Best Possible Use Is Made of Its Research Program Findings*, Washington, D.C., U.S. General Accounting Office, Report.

_____(1981), *Small Businesses Are More Active as Inventors than as Innovators in the Innovation Process*, Washington, D.C., U.S. General Accounting Office, Report PAD-82-19.

Utterback, James M. (1971), "The Process of Technological Innovation within the Firm," *Academy of Management Journal*, 14:75-88. MR(*E*)

_____(1974), "Innovation in Industry and the Diffusion of Technology," *Science*, 183:620-626. MR(*E*)

Van den Ban, A. W. (1963), "Hoe Vinden Nieuwe Landbouwmethoden-ingand'' (How a New Practice Is Introduced), *Landbouwvoorlichting*, 20:227-239. *EX(E)*

Van der Haak, Cornelius Petrus Maria (1972), *Bekendmaken en Bekend Raken*, The Hague, Netherlands, Ministry of Culture, Recreation and Social Work, Report. GS(*E*)

Von Hippel, Eric (1976), "The Dominant Role of Users in the Scientific Instrument Innovation Process," *Research Policy*, 5:212-239. MR(*E*)

Von Hippel, Eric, and Stan N. Finkelstein (1979), "Analysis of Innovation in Automated Clinical Chemistry Analyzers," *Science and Public Policy*, 6:24-37. MR(*E*)

Wagener, Donald J., et al (1981), ''Cancian's 'Upper Middle Class Conservatism' Thesis: An Application to Noncommercial Agricultural Innovations," Paper presented at the Rural Sociological Society, Guelph, Canada. RS(*E*)

Walker, Jack L. (1966), "The Diffusion of Innovations among the American States," *American Political Science Review*, 63:880-899. PS(E)

_(1971), "Innovation in State Politics," in Herbert Jacob and Kenneth N. Vines (eds.), *Politics in the American States: A Comparative Analysis*, Boston, Little, Brown. PS(*E*)

_____(1973), "Comment: Problems in Research on the Diffusion of Policy Innovations," *American Political Science Review*, 67:1186-1191. PS(*N*)

_(1976), *Setting the Agenda in the U.S. Senate: A Theory of Problem Selection*, Ann Arbor, University of Michigan, Institute of Public Policy Studies, Discussion Paper 94.

_(1977), "Setting the Agenda in the U.S. Senate: A Theory of Problem Selection,'' *British Journal of Political Science*, 7:423-445.

Wasson, Chester R. (1960), "What Is 'New' about a New Product?" *Journal of Marketing*, 25:52-56. MR(*N*)

Wellin, Edward (1955), "Water Boiling in a Peruvian Town,'' in Benjamin D Paul (ed.), *Health, Culture and Community*, New York, Russell Sage Foundation. A(*E*)

White, William James (1968), "The Adoption of Modern Dairy Practices,'' *Canadian Journal of Agricultural Economics*, 14:29-39. AE(*E*)

Whiteside, T. (1972), *The Investigation of Ralph Nader: General Motors vs. One Determined Man*, New York, Arbor House.

Whiting, Gordon C., et al (1968), *Innovation in Brazil: Success and Failure of Agricultural Programs in 76 Minas Gerais Communities*, East Lansing, Michigan State University, Department of Communication, Diffusion of Innovations Research Report 7. *C(E)*

Whitrow, G. J. (1980), *The Natural History of Time*, Oxford, England, Clarendon.

Wiebe, Gerhard D. (1952), "Merchandising Commodities and Citizenship on Television," *Public Opinion Quarterly*, 15:679-691.

Who, Osmo A. (1980), *Information and Communication: A Conceptual Analysis*, Helsinki, Finland, University of Helsinki, Department of Communication, Report.

Wilkening, Eugene A. (1952), *Acceptance of Improved Farm Practices*, Raleigh, North Carolina Agricultural Experiment Station Technical Bulletin 98. RS(*E*)

_(1956), "Role of Communicating Agents in Technological Change in Agriculture," *Social Forces*, 34:361-367. RS(*E*)

Wilkening, Eugene A., et al (1969), "Stratification and Innovative Behavior—A Re-examination of Cancian's Curvilinear Hypothesis,'' Paper presented at the Rural Sociological Society, San Francisco. RS(*E*)

Wissler, Clark (1923), *Man and Culture*, New York, Thomas Y. Crowell. A(*E*)

Wyner, Nancy (1974), *A Study of Diffusion of Innovation: Measuring Perceived Attributes of an Innovation that Determine the Rate of Adoption*, D.Ed. Thesis, New York Teachers College, Columbia University. *E(E)*

Yadav, Dharam P. (1967), *Communication Structure and Innovation Diffusion in Two Indian Villages*, East Lansing, Michigan State University, Department of Communication, Technical Report 2. *C(E)*

Zaltman, Gerald, et al (1973), *Innovations and Organizations*, New York, Wiley. MR(*N*)

Name Index

Subject Index