1

ELEMENTS OF DIFFUSION

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 the ability 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.

Niccolò Machiavelli, *The Prince* (1513)

采纳新想法是很困难的, 即使有很明显优点

很多创新要经历很久才被采纳

Getting a new idea adopted, even when it has obvious advantages, is difficult. Many innovations require a lengthy period of many 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 diffusion campaigns.

*Water Boiling in a Peruvian Village: Diffusion 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 encourages people to install latrines, burn garbage daily, control house flies, report cases of infectious diseases, and boil drinking water. These innovations involve major changes in thinking and behavior for Peruvian villagers, who do not understand the relationship of sanitation to illness. Water boiling is an especially important health practice for Peruvian villagers. Unless they boil their drinking water, patients who are cured of an infectious disease in a medical clinic often return within a short time to be treated again for the same disease.

A two-year water-boiling campaign conducted in Los Molinas, a peasant village of two hundred families in the coastal region of Peru, persuaded only eleven 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 Molinas 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, Nelida's diffusion campaign failed. To understand why, we need to take a closer look at the culture, the local environment, and the individuals in Los Molinas.

Most residents of Los Molinas are peasants who work as field hands on local plantations. Water is carried by can, pail, gourd, or cask. The three sources of water in Los Molinas 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 most villagers dislike. All three sources are subject to pollution at all times and show contamination whenever tested. Of the three sources, the irrigation ditch is the most commonly used. It is closer to most homes, and the villagers like the taste of its water.

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

What kinds of people 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.

Mrs. A: Custom-Oriented Adopter

Mrs. A is about forty and suffers from a sinus infection. The Los Molinas villagers call her the "sickly one." Each morning, Mrs. A boils a potful of water, which she uses throughout the day. She has no understanding of germ theory,

as explained by Nelida. Her motivation for boiling water 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, the hot-cold distinction serves 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 norms of Los Molinas. By custom, only the ill use cooked, or “hot” water. If an individual becomes ill, it is unthinkable to eat pork (very cold) or 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 make it appropriate.

Villagers learn from early childhood to dislike boiled water. Most can tolerate cooked water only if a flavoring, such as sugar, lemon, or herbs, is added. Mrs. A likes a dash of cinnamon in her drinking water. The village belief system does not involve the notion of bacteriological contamination of water. By tradition, boiling is aimed at eliminating the “cold” quality of unboiled water, not the harmful bacteria. Mrs. A drinks boiled water in obedience to local norms, because she perceives herself as ill. She adopted the innovation, but for the wrong reason.

Mrs. B: Persuaded Adopter

The B family came to Los Molinas a generation ago, but they are still strongly oriented toward their birthplace in the high Andes. Mrs. B worries about lowland diseases that she feels infest the village. It is partly because of this anxiety that the public health worker, Nelida, was able to convince Mrs. B to boil water. To Mrs. B, Nelida is a friendly authority (rather than a “dirt inspector,” as she is seen by other housewives) who imparts useful knowledge and brings protection from uncertain threats. Mrs. B not only boils water but has also installed a latrine and sent her youngest child to the health center for a checkup.

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 can deviate from the 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 in improving or damaging her marginal status. She is grateful to Nelida for teaching her how to neutralize the danger of contaminated water, which she perceives as a lowland peril.

Mrs. C: Rejector

This housewife represents the majority of Los Molinas families who were not persuaded by the efforts of the change agent during the two-year water-boiling 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 that one cannot see, hear, touch, or smell. Mrs. C’s allegiance to traditional village norms is at odds with the boiling of water. A firm believer in the hot-cold superstition, she feels that only the sick should drink boiled water.

Why Did the Diffusion of Water Boiling Fail?

This intensive two-year campaign by a public health worker in a Peruvian village of two hundred 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. The diffusion campaign in Los Molinas failed because the innovation was perceived as culturally inappropriate by the villagers. Local tradition links hot foods with illness. Boiling water makes water less “cold” and hence appropriate only for the sick. If a person is not ill, he or she is prohibited by village norms from drinking boiled water. Only individuals who are not integrated into local networks risk defying the community norm on water boiling. An important factor regarding the adoption rate of an innovation is its compatibility with the values, beliefs, and past experiences of individuals in 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 most nations of Latin America, Africa, and Asia). The indigenous knowledge system caused the failure of the diffusion effort for water boiling in Los Molinas.

关于创新采用率的一个重要因素是它与社会系统中个人的价值观, 信仰和过去经验的兼容性

Nelida’s failure demonstrates the importance of interpersonal networks in the adoption or rejection of an innovation. Socially an outsider, Mrs. B was marginal to the Los Molinas community, although she lived there for several years. Nelida was a more important referent for Mrs. B than were her neighbors, who shunned her. Anxious to win reflected social prestige 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 a social process, even more than a technical matter.

不仅仅是社会过程, 还是技术问题

Nelida worked with the wrong housewives if she wanted to launch a self-generating diffusion process in Los Molinas. She concentrated her efforts on village women such as Mrs. A and Mrs. B. Unfortunately, they were perceived

as a sickly one and a social outsider, respectively, and were not perceived 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. As a result, the rate of adoption of the innovation did not reach a critical mass, after which the diffusion process would have become self-sustaining.

How potential adopters view a change agent affects their willingness to adopt new ideas. In Los Molinas, Nelida was perceived differently by lower-and middle-status housewives. Most poor families saw the health worker as a "snooper" sent to Los Molinas 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 talk 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 traditional beliefs of Los Molinas. They distrusted this outsider, whom they perceived as a social stranger. Nelida, who was middle class by Los Molinas standards, was able to secure more positive results from housewives whose socioeconomic status and cultural background were more similar to hers. This tendency for more effective communication to occur with those who are more similar to a change agent occurs in most diffusion campaigns. Unfortunately, those individuals who most need the help provided by the change agent are least likely to accept it.

Nelida was "innovation-oriented" rather than "client-oriented." She was unable to put herself in the role of the village housewives, and thus her attempts at persuasion failed to reach her clients because the message did not suit their needs. Nelida talked to villagers about germ theory, which they could not (and did not need to) understand. These factors produced the diffusion failure in Los Molinas. Once the remainder of the book has been read, it will be easier to understand the water-boiling case.

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*This case illustration is based on Wellin (1955, pp. 71–103).

What Is Diffusion?

扩散是一项创新通过一定的渠道在一个社会系统的成员中传播的过程

Diffusion is the process in 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 give 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 in order to achieve certain effects (Rogers and Kincaid, 1981). A linear conception of human communication may accurately describe certain communication acts 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 followed, we often realize that the event is only one part of a total process in which information is exchanged between the two individuals. For example, a client may go to a change agent with a specific problem, and the innovation may be recommended as a possible solution to this problem. The change agent–client interaction may continue through several cycles, as a process of information exchange.

趋同(分化)的过程，两者交换信息

扩散是一种关于新想法的特殊通讯

Diffusion is a special type of communication in which the messages are about a new idea. This newness of the idea in the message content gives diffusion its special character. The newness means that some degree of uncertainty is involved in diffusion. *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. Information is a 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). A technological innovation embodies information and thus reduces uncertainty about cause-effect relationships in problem solving.

新意味着不确定

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 adopted or rejected, leading to certain consequences, social change occurs. Of course, such change can happen in other ways, too; for example, a political revolution, a natural event such as a drought or an earthquake, or a government policy.

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. In this book we use the word "diffusion" to include both the planned and the spontaneous spread of new ideas.

*Controlling Scurvy in the British Navy**

Many technologists believe 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 diffuse rapidly. Seldom is this the case. Most innovations, in fact, diffuse at a disappointingly slow rate, at least in the eyes of the inventors and technologists who create the innovations and promote them to others.

Scurvy control illustrates how slowly an obviously beneficial innovation spreads. In the early days of long sea voyages, scurvy killed more sailors than did warfare, accidents, and other causes. For instance, of Vasco da 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 an experiment to evaluate the effectiveness of lemon juice in preventing 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 in one of his four ships. These men stayed healthy. The other three ships constituted Lancaster's "control group," as their sailors were not given any lemon juice. On the other three ships, by the halfway point in the journey, 110 out of 278 sailors had died from scurvy. So many of these sailors got scurvy that Lancaster had to transfer men from his "treatment" ship in order to staff the three other ships for the remainder of the voyage.

These results were so clear that one would have expected the British Navy to promptly adopt citrus juice for scurvy prevention on all ships. Not until 1747, about 150 years later, did James Lind, a British Navy physician who knew of Lancaster's results, carry out another experiment on the *HMS Salisbury*. To each scurvy patient on this ship, Lind prescribed either two oranges and one lemon or one of five other supplements: 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 have adopted this innovation for all ship's crews on long sea voyages. In fact, it did so, but not until 1795, forty-eight years later, when scurvy was immediately wiped out. After only seventy more years, in 1865, the British Board of Trade adopted a similar policy and eradicated scurvy in the merchant marine.

Why were the authorities so slow to adopt the idea of citrus for scurvy prevention? 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 prominent figure in the field of naval medicine, and so his experimental findings did not get much attention. While scurvy prevention was generally resisted for years by the British Navy, other innovations, such as new ships and new guns, were readily accepted. So the Admiralty did not resist all innovations.

Obviously, more than just the relative advantages of an innovation, even when its benefits are clearly demonstrated, is necessary for its diffusion and adoption. The reader may think that such slow diffusion could only have happened in the distant past, before the contemporary era of scientific, experimental evaluations of innovations. On the contrary; consider the present-day case of the nondiffusion of the Dvorak keyboard.

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*This case illustration is based on Mosteller (1981).

*Nondiffusion of the Dvorak Keyboard**

Most individuals who write on a computer do not realize that their fingers tap out words on a keyboard that is known as "QWERTY," named after the first six keys on the upper row of letters. The QWERTY keyboard is intentionally inefficient and awkward. This keyboard takes twice as long to learn as it should and makes us work about twenty times harder than necessary. But QWERTY has persisted since 1873, and today unsuspecting individuals are taught to use the QWERTY keyboard, unaware that a much more efficient keyboard is available. In recent years of talking about the QWERTY keyboard with hundreds of large audiences, the present author has never encountered *anyone* who uses an alternative.

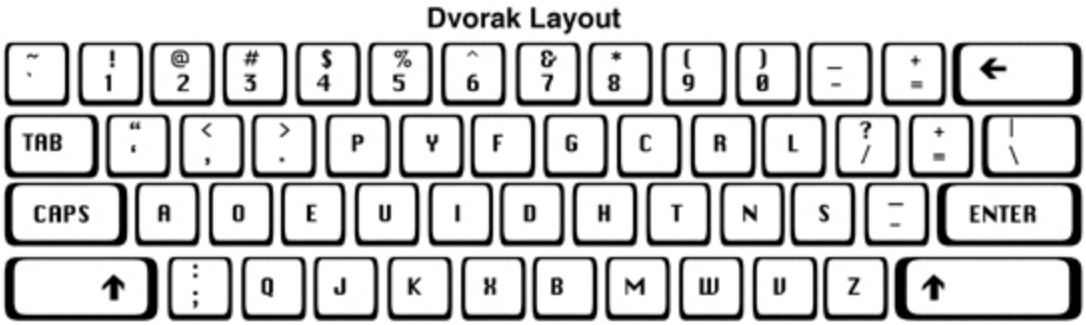
Where did QWERTY come from? Why does it persist in the face of much more efficient alternative keyboard designs? QWERTY was invented by Christopher Latham Sholes, who designed this keyboard to slow down typists. In his day, the type bars on a typewriter hung down in a sort of basket and pivoted up to strike the paper; then they fell back into place by gravity. When two adjoining keys were struck rapidly in succession, they jammed. Sholes rearranged the keys on a typewriter keyboard to minimize such jamming; he "anti-engineered" the letter arrangement in order to

make the most commonly used letter sequences awkward. By thus making it difficult for a typist to operate the machine and slowing down typing speed, Sholes's QWERTY keyboard allowed early typewriters to operate with a minimum of jamming. His design was then used in the manufacture of all typewriters. Early typewriter salesmen could impress customers by pecking out "TYPEWRITER" as all of the letters necessary to spell this word were found in the top row (QWERTYUIOP) of the machine.

Prior to 1900, most typists used the two-finger, hunt-and-peck system. Later, as touch typing became popular, dissatisfaction with the QWERTY typewriter began to grow. Typewriters became mechanically more efficient, and the QWERTY keyboard design was no longer necessary to prevent 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. Dvorak filmed people while they were typing and spent a decade analyzing which operations slowed them down. The Dvorak keyboard has the letters A,O,E,U,I,D,H,T,N, and S across the home row of the typewriter (Figure 1–1). Less frequently used letters were placed on the upper and lower rows of keys. About 70 percent of 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 (which represent 40 percent of all letters typed) on the left-hand side and the major consonants that usually accompany these vowels on the right-hand side of the keyboard.

Professor Dvorak was thus able to avoid the typing inefficiencies of the QWERTY keyboard. For instance, QWERTY overloads the left hand, which 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 (for a right-hander, as are 90 percent of the public). Only 32 percent of typing is done on the home row with the QWERTY system, compared to 70 percent with the Dvorak keyboard. The newer arrangement requires less jumping back and forth from row to row. With the QWERTY keyboard, an efficient typist's fingertips travel more than twelve miles a day, jumping from row to row. These unnecessary, intricate movements cause mental tension and carpal tunnel syndrome and lead to more typographical errors. Typists typing on the Dvorak keyboard have broken all speed records.

Figure 1-1. Layout of the QWERTY and the Dvorak Keyboards.



The Dvorak keyboard is much more efficient for typists than the QWERTY keyboard, which was designed more than a century ago to slow down typists so as to prevent the jamming of keys on early typewriters. Yet almost no one has adopted the Dvorak keyboard. Superior technological innovations do not necessarily diffuse themselves.

卓越的技术创新并不一定会自我扩散

One might expect, on the basis of its overwhelming advantages, that the Dvorak keyboard would have completely replaced the inferior QWERTY keyboard. On the contrary, after more than seventy years, almost all typists still use the inefficient QWERTY keyboard. Even though the American National Standards Institute and the 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. Unbeknown to most computer users, their machine that comes equipped with a QWERTY keyboard can easily be switched to a Dvorak keyboard. Nevertheless, a considerable effort, estimated at about a week's training, is required for someone accustomed to the QWERTY design to become proficient on a Dvorak keyboard.

Here we see that technological innovations are not always diffused and adopted rapidly, even when the innovation has obvious advantages. As the reader may have guessed by now, the present book was typed on a QWERTY keyboard.

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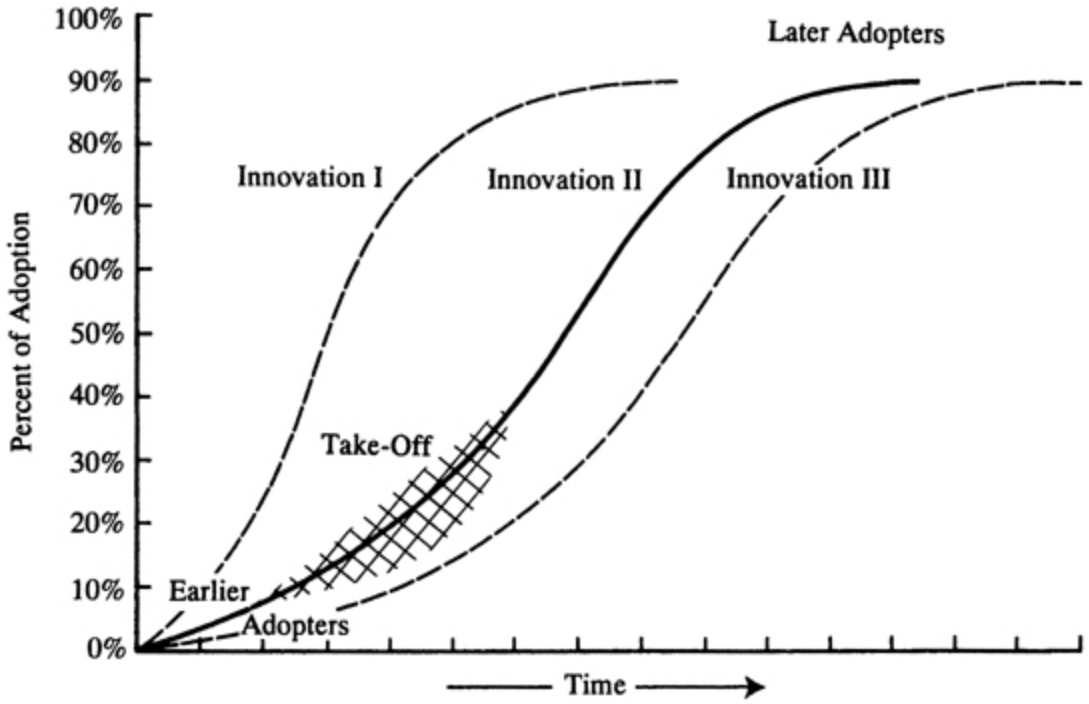
*Further details on resistance to the Dvorak keyboard are found in Dvorak et al. (1936), Parkinson (1972), Lessley (1980), and David (1986).

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 1–2). These elements are identifiable in every diffusion research study and in every diffusion campaign or program (such as the attempted diffusion of water boiling in a Peruvian village).

Figure 1-2. The Diffusion Process



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.*

The following description of these four elements in diffusion constitutes an overview of the main concepts that will then 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 an 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. "Newness" of an innovation may be expressed in terms of knowledge, persuasion, or a decision to adopt.

Among the important research questions addressed by diffusion scholars are (1) how earlier adopters differ from later adopters of an innovation (see Chapter 7), (2) how the perceived attributes of an innovation, such as its relative advantage, compatibility, and so on, affect its rate of adoption, whether relatively rapidly or more slowly, as is detailed in Chapter 6, and (3) why the S-shaped diffusion curve "takes off" at about 10 to 20 percent adoption, when interpersonal networks become activated so that a critical mass of adopters begin using an innovation (see Chapter 8). It should not be assumed that the diffusion and adoption of all innovations are necessarily desirable. Some harmful and uneconomical innovations are not desirable for either an individual or the social system. Further, the same innovation may be desirable for one adopter in one situation but undesirable for another potential adopter whose situation differs. For example, mechanical tomato pickers were adopted rapidly by large commercial farmers in California, but these machines were too expensive for small-sized tomato growers, and thousands of farmers were thus forced out of tomato production (see Chapter 4). Similarly, at present about half of U.S. households own a personal computer. The half who do not perceive that they have little use for a computer, or else they use a computer at work or in a cybercafé.

TECHNOLOGICAL INNOVATIONS, INFORMATION, AND UNCERTAINTY Most of the new ideas whose diffusion has been analyzed are technological innovations, and we often use the word "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 a material or physical object, 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 a frame that protects these electronic components, and (2) "computer software," consisting of the coded commands, instructions, manuals, and other information aspects of this tool that allow us to use it for certain tasks. This example illustrates the close relationship between hardware and software, between a tool and the way it is used.

We often think of technology mainly in terms of hardware. Indeed, sometimes the hardware side of a technology is dominant. But in other cases, a technology may be almost entirely composed of information; examples are a political philosophy such as Marxism, a religious idea such as Christianity, a news event, and a policy such as a municipal no-smoking ordinance. 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. Such idea-only innovations have a relatively lower degree of observability and thus a slower rate of adoption.

A number of new products involve both a hardware component and a software component, with the hardware purchased first so that the software component can then be utilized. Examples are VCRs and videotapes, compact disc players and CDs, and personal computers and computer software programs. Often a company will sell a hardware product at a relatively low price in order to capture market share and then sell its software at a relatively high price in order to recover profits. An example is video game players; these are sold at a fairly low price, but the video games to be played on them are sold at a relatively high price. This "shaver-and-blades" strategy is commonly used to speed the diffusion of consumer electronics innovations.

Even though the software component of a technology is often not so apparent, we should not forget that a technology almost always represents a mixture of hardware and software. According to our definition, technology is a means of uncertainty reduction that is made possible by information about the cause-effect relationships on which the technology is based. This information often results from the scientific R&D activities that developed the technology. A technological innovation usually has at least some degree of benefit for its potential adopters, but this advantage is not always clear cut to those intended adopters. They are seldom certain that an innovation represents a superior alternative to the previous practice that it would replace, at least when they initially learn about it.

Knowing of a technological innovation creates uncertainty about its consequences in the mind of potential adopters. Will the innovation solve an individual's perceived problem? The potential advantage of a new idea impels an individual to exert effort to learn more about the innovation. Once such information-seeking activities reduce uncertainty about the innovation's expected consequences to a tolerable level, a decision concerning adoption or rejection can be made. If a new idea is then used, further evaluative information about its effects is obtained. Thus, *the innovation-decision process is essentially an information-seeking and information-processing activity in which an individual is motivated to reduce uncertainty about the advantages and disadvantages of the innovation* (see Chapter 5).

The main questions that an individual typically asks about a new idea include "What is the innovation?" "How does it work?" "Why does it work?" "What are the innovation's consequences?" and "What will its advantages and disadvantages be in my situation?"

TECHNOLOGY CLUSTERS An important conceptual and methodological issue is how to determine the boundaries around a technological innovation. The problem is how to determine where one innovation stops and another begins. If an innovation is defined as an idea that is perceived as new, the boundary question 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, some U.S. households that recycle paper also recycle bottles and cans, although many families recycle only paper. Presumably the two recycling behaviors represent two innovations that are part of an interrelated cluster of several recycling ideas. A *technology cluster* consists of one or more distinguishable elements of technology that are perceived as being closely interrelated. Some change agencies promote a "package" of innovations because they find that the innovations are thus adopted more rapidly. An example of a technology cluster was the package of rice- or wheat-growing innovations that led to the Green Revolution in the Third World

countries of Latin America, Africa, and Asia. In addition to the so-called miracle varieties of rice or wheat, the cluster included chemical fertilizers, pesticides, and thicker planting of seeds. If the entire cluster were adopted by a farmer, crop yields approximately tripled.

Past diffusion research generally investigated each innovation as if it were independent from other innovations. This oversimplification represents a dubious assumption, in that an adopter's experience with one innovation obviously influences that individual's perception of the next innovation to diffuse through the individual's system. In reality, the innovations diffusing at about the same time in a system are interdependent. While it is much simpler for diffusion scholars to investigate the spread of each innovation as an independent event, this is a distortion of reality. More scholarly attention should be paid to technology clusters.

PERCEIVED ATTRIBUTES OF INNOVATIONS It should not be assumed, as it sometimes has been in the past, that all innovations are equivalent units of analysis. This assumption is a gross oversimplification. While consumer innovations such as cellular telephones and VCR's required only a few years to reach widespread adoption in the United States, other new ideas, such as using the metric system or seat belts in cars, require decades to reach complete use. The characteristics of innovations, as perceived by individuals, help to explain their different rates 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 important factors. 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 will be.

创新是否具有大量的客观优势并不那么重要. 重要的是个人是否认为创新是有利的. 一项创新的相对优势越大, 其被采用的速度就越快

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 incompatible with the 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, which is a relatively slow process. An example of an incompatible innovation is the use of contraceptive methods in countries where religious beliefs discourage use of family planning, as in certain Muslim and Catholic nations. Previously in this chapter, we saw how the innovation of water boiling was incompatible with the hot-cold belief system in the Peruvian village of Los Molinas.

兼容性是一项创新被认为与现有价值, 过去经验和潜在采用者的需求相一致的程度

3. *Complexity* is the degree to which an innovation is perceived as difficult to understand and use. Some innovations are readily comprehended by most members of a social system; others are more complicated and are adopted more slowly. For example, the villagers in Los Molinas did not understand germ theory, which the health worker tried to explain to them as a reason for boiling their drinking water. New ideas that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and understandings, such as the Dvorak keyboard.
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. Even then, many years of trial occurred before the typical Iowa farmer planted 100 percent of his corn acreage in hybrid seed. 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.

可实验性

5. *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 the friends and neighbors of an adopter often request innovation evaluation information about it. Solar water-heating adopters, for example, are often found in neighborhood clusters in California, with three or four adopters located on the same block. Many other city blocks have no solar flat-plate collectors. The clustering of visible innovations is one evidence for the importance of observbility (and peer-to-peer networks). Other consumer innovations, such as home computers, are relatively low in observability and thus diffuse more slowly.

刺激同行讨论

Innovations that are perceived by individuals as having greater relative advantage, compatibility, trialability, and observability and less complexity will be adopted more rapidly than other innovations. Past research indicates that these five qualities are the most important characteristics of innovations in explaining the rate of adoption. The first two attributes, relative advantage and compatability, are particularly important in explaining an innovation's rate of adoption.

RE-INVENTION For the first several decades of diffusion research, it was assumed that an innovation was an invariant quality that did not change as it diffused. I remember interviewing an Iowa farmer during my Ph.D. dissertation research at Iowa State University in 1954. I inquired about his adoption of 2,4-D weed spray. 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 lengthy remarks, I simply checked "adopter" on my interview questionnaire. The concept of re-invention was not yet in my theoretical repertoire, so I condensed the farmer's experience into my existing categories.

In the 1970s, diffusion scholars began to study the concept of *re-invention*, defined as the degree to which an innovation is changed or modified by a user in the process of adoption and implementation. Some researchers measure re-invention as the degree to which an individual's use of a new idea departs from the core or "mainline" version of the innovation promoted by a change agency (Eveland et al., 1977). Once scholars became aware of the concept of re-invention and began to measure it, they began to find that a considerable degree of re-invention had occurred for many innovations. Some innovations are 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 the seed for only the first generation. Similarly, genetically modified (GM) corn seeds were sold in the early 2000s with a "killer gene" that destroys insects (such as European corn borers, an important pest, but also, unfortunately, many monarch butterfly caterpillars) when they eat the corn leaves. The second generation of this seed will not germinate, forcing the farmer to purchase new GM seed corn each year.

Certain other innovations are more flexible in nature, and they are re-invented by many adopters who implement them in a wide variety of different ways. 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. Many adopters want to participate actively in customizing an innovation to fit their unique situation. Later in this book, we show that an innovation diffuses more rapidly when it can be re-invented and that its adoption is more likely to be sustained.

Given that an innovation exists, communication must take place if the innovation is to spread. We now turn our attention to this second element in the diffusion process.

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. 扩散是特殊的通讯, 交换的是新想法 Diffusion is a particular type of communication in which the message content that is exchanged is concerned with a new idea. The essence of the diffusion process is the information exchange through 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 has experienced using, the innovation, (3) another individual or other unit that does not yet have knowledge of, or experience with, 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 a pair of individuals determines the conditions under which a source will or will not transmit the innovation to the receiver and the effect of such a transfer.

Mass media channels are usually the most rapid and efficient means of informing 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 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 accept a new idea, especially if the interpersonal channel links two or more individuals who are similar in socioeconomic status, education, or other important ways. *Interpersonal channels* involve a face-to-face exchange between two or more individuals. In addition to mass media and interpersonal communication channels, interactive communication via the Internet has become more important for the diffusion of certain innovations in recent decades.

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 already adopted the innovation. This dependence on the experience of near peers suggests that the heart of the diffusion process consists of the modeling and imitation by potential adopters of their network partners who have previously adopted. Diffusion is a very social process that involves interpersonal communication relationships (see 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 similar, or homophilous. *Homophily* is the degree to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status, and the like. In a free-choice situation, when an individual can interact with any one of a number of other individuals, the tendency is to select someone who is very similar. *Heterophily*, the opposite of homophily, is defined as the degree to which two or more individuals who interact are different in certain attributes.

Homophily occurs when similar individuals belong to the same groups, live or work near each other, and share similar interests. Physical and social propinquity makes homophilous communication more likely to occur than heterophilous communication. Such communication is also more likely to be effective and thus to be rewarding to the participants. More effective communication occurs when two or more individuals are homophilous. When they share common meanings and a mutual subcultural language, and are alike in personal and social characteristics, the communication of new 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 rewarding to both participants.

One of the most distinctive problems in the diffusion of innovations is that the participants are usually quite heterophilous. A change agent, for instance, is more technically competent than his or her clients. This difference frequently leads to ineffective communication as the two individuals do not speak the same language. However, when two individuals are identical regarding their technical grasp of an innovation, diffusion cannot occur as there is no new information to exchange. The nature of diffusion demands that at least some degree of heterophily be present between the two participants in the communication process. Ideally, the individuals would be homophilous on all other variables (education, socioeconomic 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 of, and experience with, an innovation are highly related to socioeconomic status, education, and so forth.

3. Time

Time is a third element in the diffusion process. Much other behavioral science research is timeless in the sense that the time dimension is simply ignored or does not matter. 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 the respondents' recall) can be criticized (see Chapter 3). The time dimension is involved in diffusion in (1) the innovation-decision process by which an individual passes from first knowledge of an innovation through its adoption or rejection, (2) 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) an innovation's rate of adoption in a system, usually measured as the number of members of the system who 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 the formation of an attitude toward the innovation, to a decision to adopt or reject, to implementation and use of the new idea, and to confirmation of this decision. We conceptualize five main steps in the innovation-decision process: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation.

Knowledge is gained when an individual (or other decision-making unit) learns of the innovation's existence and gains some understanding of how it functions. *Persuasion* takes place when an individual forms a favorable or unfavorable attitude toward the innovation. *Decision* occurs when an individual engages in activities that

lead to a choice to adopt or reject the innovation. *Implementation* takes place when an individual puts an innovation into use. Re-invention is especially likely to occur at the implementation stage. *Confirmation* occurs when an individual 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.

获取信息逐步降低不确定性

The innovation-decision process is an information-seeking and information-processing activity in which an individual obtains information in order to gradually decrease uncertainty about the innovation. At the knowledge stage, an individual mainly seeks software information that is embodied in the 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 the 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 decision 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 for his or her own particular situation. Interpersonal communication networks with near peers are particularly likely to convey such evaluative information about an innovation. Mass media channels are not very important at this stage because their messages are general in nature, and an individual deciding to adopt wants to know specific information: Will the innovation be beneficial to me in my particular situation? Subjective evaluations of a new idea by other individuals 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 *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 has 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 an 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 (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. Exceptions to the usual sequence of these five stages may occur for some individuals under some conditions, such as when the decision stage precedes the persuasion stage (perhaps an individual was ordered to adopt by some authority figure).

The *innovation-decision period* is the length of time required to pass through the innovation-decision process. Individuals vary in this innovation-decision period, with some people requiring many years to adopt an innovation, while other people move rapidly from knowledge to implementation.

The present discussion of the innovation-decision process is mainly at the level of a single individual and of individual-optional innovation-decisions. But many innovation-decisions are made by organizations, communities, or other types of adopting units, rather than by individuals. For example, an organization may decide to implement an e-mail system on the basis of a staff decision or an official's authority decision. An individual employee in the organization may have little or no say in this innovation-decision. When an innovation-decision is made by a system, rather than by an individual, the decision process is more complicated because a number of individuals are involved (see Chapter 10).

So time is an important dimension in the innovation-decision process.

更早采纳的程度

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 more efficient to refer to the individual as being in the "late majority" or in some other adopter category. This shorthand notation saves words and contributes to clearer understanding. 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 or she is of relatively lower socioeconomic status, makes little use of mass media channels, and learns about most new ideas from peers via interpersonal communication channels. *Adopter categories,* the classifications of members of a social system on the basis of innovativeness, include: (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, reaching outside 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, they cannot depend upon the subjective evaluations of the innovation from other members of their system. We shall present a concise word picture of each of the adopter categories in Chapter 7.

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

RATE OF ADOPTION A third way in which the time dimension is involved in the diffusion of innovations concerns the *rate of adoption*, defined as 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 (a year or a month, for example); these are the innovators. Soon the diffusion curve begins to climb, as more and more individuals adopt in each succeeding time period. Eventually, the trajectory of the rate of adoption begins to level off, as fewer and fewer individuals remain who have not yet adopted the innovation. 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. Other innovations have a slower rate of adoption, and the S-curve is 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, while others are adopted more slowly (see Chapter 6).

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 the rate of adoption is measured for an innovation in a system, rather than for an individual as the unit of analysis (this variable is innovativeness). The system may be a community, an organization, or some other structure. Innovations that are perceived by individuals as possessing greater relative advantage, compatibility, and the like, have a more rapid rate of adoption, as discussed previously.

There are also differences in the rate of adoption for the same innovation in different social systems. Many aspects of diffusion cannot be explained by just individual behavior. The system has a direct effect on diffusion through its norms and other system-level qualities, as well as an indirect influence through the behavior of its individual members.

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 peasant families in a Peruvian village, 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.

Diffusion occurs within a social system. 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 deal with how the system's 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. Each of these issues involves 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 exists in a 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 system; it allows one to predict behavior with some degree of accuracy. Thus, structure represents a type of information, in that it decreases uncertainty. An illustration of this predictability is provided by structure in a bureaucratic organization such as a government agency. The well-developed social structure in such a system consists of hierarchial positions, giving individuals 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, an informal structure also exists in the interpersonal networks linking a system's members, tracing 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 defined homophily as the degree to which two or more individuals in a system talk with others who are similar to them. 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. This situation might occur when complete strangers first come together. However, regular patterns soon begin to occur in the communication network of the system. These aspects of communication structure predict, in part, the behavior of individual members of the social system, including when they adopt an innovation.

社会结构是双刃剑

The structure of a social system can facilitate or impede the diffusion of innovations. 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 veins and arteries."

Compared to other aspects of diffusion research, however, there have been relatively few studies of how the social or communication structure affects the diffusion and adoption of innovations in a system. It is a rather complicated matter to untangle the effects of a system's structure on diffusion, independent from the effects of the characteristics of individuals that make up the system. 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. Rogers and Kincaid (1981) identified two Korean women in their study of the diffusion of family planning in Korea. Both women are illiterate, are married, have two children, and are twenty-nine years of age. The husbands of both women are high school graduates; each operates a farm of five acres. One might expect that both women would be about equally likely, or unlikely, to adopt a new contraceptive method.

But the women are different in one crucial respect: they live in different villages, one in Village A and one in Village B. Family-planning methods have been adopted by 57 percent of the eligible couples in Village A and by only 26 percent in Village B. The social and communication structures of these two villages are quite different regarding the diffusion of contraceptives, even though contraceptives were promoted equally in both villages by the national family-planning program. We predict that the woman in Village A will 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 to encourage her to adopt since they themselves have adopted, and the village leaders in Village A are especially committed to family planning, while in Village B they are not.

This example shows how a system's structure can affect 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 an 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) also illustrates the importance of village norms in affecting the rate of adoption of innovations. For example, their study of twenty-four Korean villages found large differences from village to village, both in the level of adoption of family-planning and in the adoption of particular types of family-planning methods. One village had 51 percent adoption of the intrauterine device (IUD) and only one vasectomy adopter, while another village had 23 percent adoption of vasectomy. Yet another was a "pill village" in which all the adopters of family planning decided to use contraceptive pills. 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 main explanation for the different contraceptive behavior from village to village was these systems' norms.

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

of a system tell individuals what behavior they are expected to perform.

A system's norms can be a barrier to change, as in the previous example of water boiling in a Peruvian community. Such resistance to new ideas is often found in norms on food habits. In India, for example, sacred cows roam the countryside while millions of people are malnourished. Pork is not consumed by Muslims and Jews. Polished white rice is eaten in most of Asia and the United States, even though whole rice is much 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 such as a village.

OPINION LEADERS AND CHANGE AGENTS The most innovative member of a system is very often perceived as a deviant from the social system and is accorded a status of low credibility by the average members of the system. This individual's role in diffusion (especially in persuading others to adopt the innovation) is therefore very limited. Certain other members of the system function as opinion leaders. They provide information and advice about innovations to many other individuals 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. This informal leadership is not 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. When the social system is oriented to change, the opinion leaders are more innovative; but when the system's norms are opposed to change, the behavior of the leaders also reflects this norm. Through their conformity to the system's norms, opinion leaders serve as a model for the innovation behavior of their followers. Opinion leaders thus exemplify and express the system's structure.

Many systems have both innovative opinion leaders and leaders who oppose change. Influential persons can lead in the spread of new ideas, or they can head an active opposition. When opinion leaders are compared with their followers, they (1) are more exposed to all forms of external communication and thus are somewhat more cosmopolite, (2) have somewhat higher socioeconomic status, and (3) are more innovative (although their degree of innovativeness depends, in part, on the system's norms). The most striking characteristic 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. An 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 respect with which the opinion leader is held can be lost, however, if an opinion leader deviates too far from the norms of the system. Opinion leaders can be "worn out" by change agents who overuse them in diffusion activities. Opinion leaders may begin to be perceived by their peers as too much like professional change agents and therefore lose their credibility with their former followers.

Opinion leaders are members of the social system in which they exert their influence. A different kind of individual with influence in the system is 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. The change agent usually seeks to obtain the adoption of new ideas but may also attempt to slow down diffusion and prevent the adoption of undesirable innovations. Change agents often use opinion leaders in a social system as their lieutenants in diffusion activities.

Change agents are usually professionals with a university degree in a technical field. 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 they are promoting. Many change agencies employ 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 homophilous with the average client and thus provide one means of bridging the heterophily gap between professional change agents and their client audience.

TYPES OF INNOVATION-DECISIONS The social system has yet another important influence in the diffusion of new ideas. Innovations can be adopted or rejected (1) by an individual member 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 the other members of the system. Even in this case, the individual's

decision may be influenced by the norms of the system and by communication through interpersonal networks. The decision of an individual housewife in Los Molinas to adopt or reject boiling water was an optional innovation-decision, although this choice was influenced by community-level factors, such as norms on the hot-cold complex. The distinctive aspect of optional innovation-decisions is that the individual is the main unit of decision making, rather than the social system.

选择性创新决策的独特之处在于，个人是决策的主要单位，而不是社会系统

The classical diffusion model evolved out of early diffusion 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. In more recent decades, however, the scope of the diffusion paradigm has included 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 units in the system usually must conform to the system's decision once it is made.
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. An individual member of the system has little or no influence in the authority innovation-decision; he or she simply implements the decision once it is made by an authority. For instance, some years ago the president of a large U.S. computer corporation decided that all male employees should wear a white shirt, a conservative necktie, and a dark suit; this authority decision had to be followed by every man who worked for the computer 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 a say in the decision), to authority decisions (where the adopting individual has no influence in the innovation-decision). Collective and authority decisions are more common than optional decisions in most organizations, such as factories, schools, or government organizations, in comparison with other fields such as agriculture and consumer behavior, where most innovation-decisions by farmers and consumers are optional.

Generally, the fastest rate of adoption of innovations stems 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 may be circumvented by members of a system during their implementation.

随时间改变而改变

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 an option by the car's owner, who had to pay for the cost of installation. Then, in 1966, 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 (the law was passed by a consensus of the members of Congress). The decision by a driver or passengers to fasten the belts when in the car was still an optional decision. However, in 1974, a federal law required all new cars to be equipped with a seat belt–ignition interlock system that prevented the driver from starting the engine until the driver and the front-seat passenger had fastened their seat belts. So for one year, the decision to fasten seat belts became a collective authority-decision. The public reaction to this draconian approach was so negative that the U.S. Congress reversed the law, and the fastening of auto seat belts again became an individual-optional decision. Then, during the late 1980s, many states passed laws requiring seat belt use; if the police apprehend someone not using a seat belt, they issue a traffic citation. Thus the seat belt decision again became somewhat more authoritarian.

Smoking cigarettes was completely a matter of individual choice until the late 1980s, when scientific evidence began to accumulate on the health dangers of second-hand smoke. U.S. airlines adopted a policy prohibiting smoking on all domestic flights. The Environmental Protection Agency (EPA) published a report classifying environmental smoke as a carcinogen (that is, as cancer-causing). By 1990, many communities, especially in California, adopted no-smoking ordinances that precluded smoking in such public places as city buildings, restaurants, and bars. Adoption of these no-smoking ordinances diffused rapidly among U.S. municipalities, until by 2002, some 2,400 cities had adopted. Each city made an optional innovation-decision, but once it was made by a city council, everyone in the city was forced to avoid smoking in public places (an authority decision). As a result of municipal no-smoking ordinances, the number of smokers in the United States has continued to decline, until in 2002 only 25 percent of adults were smoking.

This illustration demonstrates a fourth type of innovation-decision that is a sequential combination of two or more of the three types discussed previously. *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 adopt a new idea only after (or until) his or her system's innovation-decision. In the seat belt example just discussed, until the 1966 law (a collective innovation-decision by elected legislators representing the public), it was difficult for a vehicle owner to make an optional decision to install seat belts. In the no-smoking illustration, an individual must adopt the innovation of not smoking in public places, once this policy is adopted by the city council.

The distinctive aspect of contingent decision making is that two (or more) tandem decisions are required; either of the decisions may be optional, collective, or authority. The social system is involved directly in collective, authority, and contingent innovation-decisions.

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 (see 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. Three classifications of consequences are:

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 or not the changes are recognized and intended by the members of a social system.

Change agents usually introduce innovations into a client system that they expect will have consequences that 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. For instance, the steel ax was introduced by missionaries to an Australian aborigine tribe (Sharp, 1952). The change agents intended that the new tool would raise levels of living and material comfort for the tribe. But the new technology also led to a breakdown in family structure, the rise of prostitution, and "misuse" of the innovation itself. Change agents can often anticipate and predict an 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 an innovation's *meaning,* the subjective perceptions of the innovation by the clients.

*Diffusion of Hybrid Corn in Iowa**

Ryan and Gross's (1943) study of the diffusion of hybrid seed corn in Iowa is the most influential diffusion study of all time, despite the 5,200-plus diffusion investigations conducted since this pioneering study. The hybrid corn investigation includes each of the four main elements of diffusion (an innovation, communication channels, time, and the social system) that we have just discussed and serves to illustrate these elements.

Hybrid corn became one of the most important new agricultural technologies after it was released to Iowa farmers in 1928. The new seed ushered in the agricultural innovations in the 1930s through the 1950s that led to an agricultural revolution in farm productivity. Hybrid seed was developed by agricultural scientists at Iowa State University and other state land-grant universities. The diffusion of hybrid seed was heavily promoted by the Iowa Agricultural Extension Service and by salesman from seed corn companies. Hybrid corn yielded an increased harvest of about 20 percent per acre over the open-pollinated varieties that it replaced. It was also more drought-resistant and better suited to harvesting with mechanical corn pickers. 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 an Iowa farmer had to make important changes in his corn-growing behavior. Hybrid seed corn ushered in a new era of farmers' dependence on agribusiness companies that sold chemical fertilizers, pesticides, and other farm inputs.

When Professor Bryce Ryan, fresh from his Ph.D. studies in sociology at Harvard University, arrived at Iowa State

University in 1939, he chose hybrid corn as the innovation of study in his investigation of social factors in economic decisions. This interest drew him to study how Iowa farmers' social relationships with their neighbors influenced them to adopt hybrid corn. Ryan had read anthropological work on diffusion while he was at Harvard, so he cast his Iowa study of hybrid corn in a diffusion framework. But unlike the qualitative methods used in anthropological studies of diffusion, the Iowa investigation mainly utilized qualitative data from survey interviews with Iowa farmers about their adoption of hybrid corn seed.

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

Neal Gross was from an urban background in Milwaukee, Wisconsin, and initially felt somewhat uncomfortable interviewing Iowa farmers. Someone in Ames told Gross that farm people got up very early in the morning, so on his first day of data gathering, he arrived at a respondent's home at 6:00 A.M., while it was still half dark. By the end of this first day, Gross had interviewed twenty-one people, and he averaged an incredible fourteen interviews per day for the entire study! Today, a survey interviewer who averages four interviews per day is considered hardworking. During one personal interview, an Iowa farmer, perhaps slyly leading him on, asked Gross for advice about controlling horse nettles. Gross had never heard of horse nettles. He told the farmer that he should call a veterinarian to look at his sick horse (horse nettles are actually a kind of noxious weed).

Neal Gross personally interviewed 345 farmers in the two Iowa communities, but twelve farmers operating less than twenty acres were discarded from the data analysis, as were 74 respondents who had started farming after hybrid corn began to diffuse. Thus, the data analysis was based on 259 respondents.

When all of the data were gathered, Ryan and Gross coded the farmers' interview responses into numbers. The diffusion researchers analyzed the data by hand tabulation and with a desk calculator (computers were not available for data analysis until some years later). Within a year, Gross (1942) completed his master's thesis on the diffusion of hybrid corn, and shortly thereafter Ryan and Gross (1943) published their research findings in the journal *Rural Sociology* (this article is the most widely cited publication from the study, although there are several others). This paper became the founding document for the research specialty of the diffusion of innovations. Several previous studies had been completed on the diffusion of agricultural innovations, but they did not lead to a research tradition because they did not create a research paradigm for the diffusion of innovations (Valente and Rogers, 1995). The Ryan and Gross (1943) study established the customary research methodology to be used by most diffusion investigators: retrospective survey interviews in which adopters of an innovation are asked when they adopted, where or from whom they obtained information about the innovation, and the consequences of adoption. Ryan and Gross (1943) popularized the term "diffusion" (which had previously been used by anthropologists), although they did not use the concept of "innovation." That term would come from later scholars.

All but 2 of the 259 farmers had adopted hybrid corn in the thirteen years between 1928 and 1941. 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). Then the rate of adoption leveled off as fewer and fewer farmers remained to adopt the new idea. The overall shape of the rate of adoption looked like an "S" (see Figure 1–2).

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 also more cosmopolite, as measured by their number of trips to Des Moines, Iowa's largest city, located about seventy-five miles from the two study communities.

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 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, an indication that the innovation-decision process involved considerable deliberation, 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 of about one acre, 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 frequently cited channel leading to persuasion. Thus 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 exchanges of their personal experiences with hybrid seed were at the heart of diffusion. When enough such positive experiences were accumulated by the innovators, and especially by early adopters, and exchanged with other farmers in the community, the rate of adoption took off. This threshold for hybrid corn occurred in 1935. After that point, it would have been impossible to halt its further diffusion. 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 did you obtain information about hybrid corn?" The sample design, which consisted of a complete enumeration in two communities, would have made the use of such communication network questions appropriate. 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 had spread in the two Iowa communities as a kind of social snowball: "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 new stimulus to the remaining ones." 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 by those individuals who have already adopted an innovation to those individuals who are influenced to follow their lead. Diffusion is fundamentally a social process.

Study of the invisible college of rural sociologists investigating diffusion as of the mid-1960s identified the researchers who first utilized a new concept and/or methodological tool in studying diffusion (Crane, 1972). Ryan and Gross launched fifteen of the eighteen most widely used intellectual innovations in the rural sociology diffusion research tradition. So Bryce Ryan and Neal Gross played key roles in forming the classical diffusion paradigm. The hybrid corn study has left an indelible stamp on the history of all diffusion research.

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*This case illustration is based on Ryan and Gross (1943), Gross (1942), Ryan and Gross (1951), and Valente and Rogers (1995).

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 the spread of messages that are perceived as new ideas. *Communication* is a process in which participants create and share information with one another in order to reach a mutual understanding. Diffusion has a special character because of the newness of the idea in the message content. Thus some degree of uncertainty and perceived risk is involved in the diffusion process. An individual can reduce this degree of uncertainty 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) that is *communicated* through certain *channels* (3) *over time* (4) among the members of a *social system.*

1. Innovation

An *innovation* is an idea, practice, or object perceived as new by an individual or other unit of adoption. Most 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 a material or physical object, and (2) *software*, consisting of the knowledge base for the tool.

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.

2. Communication Channels

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 a 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 role models, whose innovation behavior tends to be imitated by others in their system.

A distinctive aspect of diffusion is that at least some degree of heterophily is usually present in communication about innovations. *Heterophily* is the degree to which two or more 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 two or more individuals who interact are similar in certain attributes. 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 achieving effective communication.

3. Time

Time is involved in diffusion in (1) the innovation-diffusion process, (2) innovativeness, and (3) an innovation's rate of adoption. 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 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 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 their innovativeness: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards. *The rate of adoption* is the relative speed with which an innovation is adopted by members of a social system.

4. 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. One aspect of social structure is *norms,* the established behavior patterns for the members of a social 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 among 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 three types of innovation-decisions: *Contingent innovation-decisions* are choices to adopt or reject that are made only after a prior innovation-decision.

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