11

CONSEQUENCES OF INNOVATIONS

Changing people's customs is an even more delicate responsibility than surgery.

Edward H. Spicer, *Human Problems in Technological Change* (1952), p. 13.

Consequences are the changes that occur an individual or a social system as a result of the adoption or rejection of an innovation. Invention and diffusion are but means to an ultimate end: the consequences that result from adoption of an innovation. In spite of the importance of consequences, they have received relatively little study by diffusion researchers. Furthermore, the data we have about consequences are rather "soft" in nature, based mainly on case studies, which makes it difficult to generalize about consequences. Here we establish categories for classifying consequences, but we cannot predict when and how these consequences will happen. The unpredictability of an innovation's consequences, at least in the long term, is one important type of uncertainty in the diffusion process.

Change agents generally give little attention to consequences. They often assume that adoption of a given innovation will produce mainly beneficial results for adopters. This assumption is one expression of the pro-innovation bias. Change agents should recognize their responsibility for the consequences of innovations that they introduce. Ideally, they should be able to predict the advantages and disadvantages of an innovation before introducing it to their clients. This is seldom done, and often it cannot be done.

The introduction of snowmobiles to Lapp reindeer herders in northern Finland illustrates how difficult it is to predict the effects of technology.

*Snowmobile Revolution in the Arctic**

In the United States the snowmobile is used for winter recreation. Since the invention of the "Ski-Doo," a one-person snow vehicle, in 1958, the adoption of snowmobiles spread dramatically, and within a dozen years more than a million were in use in North America. Some outcry against the Ski-Doo (which quickly became a generic name for all makes of snowmobiles) was voiced, owing to the noise pollution they caused in previously peaceful outdoor areas of the United States and Canada.

But among the Skolt Lapps, a reindeer-herding people of northern Finland who live above the Arctic Circle, the rapid introduction of snowmobiles caused far-reaching consequences that were "disastrous" (Pelto, 1973). One method of investigating the consequences of technological innovation is for a scholar to intensively study a small community. Dr. Pertti Pelto, an anthropologist then at the University of Connecticut, lived among the Skolt Lapps in the Sevettijärvi region of northern Finland for several years, beginning in 1958, prior to the introduction of snowmobiles in 1962. Pelto returned to this community repeatedly over the next decade in order to assess the impacts of the snowmobile revolution through participant observation, personal interviews with the Lapps, and via collaboration with a research assistant/key informant (who was the first Skolt Lapp to buy a snowmobile). Pelto chose to concentrate on a single technological innovation because its consequences were so striking and hence relatively easier to identify. Many of the impacts of the Ski-Doo were very unfavorable. Pelto argued that the snowmobile represents a class of technological innovations that shifts energy sources from local and autonomous origins (reindeer-drawn sleds, in this case) to a dependence upon external sources (snowmobiles and gasoline).

Prior to the introduction of snowmobiles, the Skolt Lapps herded semi-domesticated reindeer for their livelihood. Reindeer meat was the main food, and reindeer sleds were the principal means of transportation. Rein-

*This case illustration is based on Pelto (1973), Pelto et al. (1969), and Pelto and Muller-White (1972).

deer hides were used for making clothing and shoes. Surplus meat was sold at trading stores for cash to buy flour, sugar, tea, and other staples. The Lapps saw themselves mainly as reindeer herders, and prestige was accorded to men who had a good string of draft reindeer. Lapp society was an egalitarian system in which each family had approximately equal numbers of animals. Skolt children received a "first tooth reindeer," a "name-day reindeer," and reindeer as gifts on various other occasions, including as wedding gifts, so that a new household began with a small herd of the beloved animals. The Lapps felt a special relationship with their reindeer and treated them with great care. The reindeer was the central object in Lapp culture.

In 1961, a Bombardier Ski-Doo from Canada was displayed in Rovaniemi, the capital city of Finnish Lapland. A schoolteacher purchased this snowmobile for recreational travel but soon found that it was useful for hauling wood and store-bought supplies. Snowmobiles soon began to be used for reindeer herding. Within a year, two Ski-Doos were purchased for reindeer herding in an area where the land was forested and rocky. The Lapp reindeer men had to drive their machines by standing up on the footboards or kneeling on the seat, instead of riding in the usual straddle position (as on a motorcycle). They drove standing erect so that they could spot reindeer at a greater distance and steer around rocks, trees, and other obstacles. But the erect riding style of the Lapps was dangerous when they hit an obstruction, as the driver was thrown forward. Breakdowns of the snowmobiles occurred often in the rough Lappish terrain.

Despite these problems, the rate of adoption of snowmobiles was very rapid. Three snowmobiles were adopted in the second year of diffusion, five more the next year, then eight more, and sixteen in 1966–1967, the fifth year. By 1971, almost every one of the seventy-two households in Sevettigärvi (the village studied by Professor Pelto) had at least one snowmobile. An improved model, the Motoski, was introduced from Sweden. It had a more powerful motor and was better suited to driving over rough terrain.

The main advantage of the snowmobile was faster travel. The round trip from Sevettigärvi to buy staple supplies in stores in Norway was reduced from three days by reindeer sled to five hours by snowmobile. Within a few years of their initial introduction, snowmobiles completely replaced skis and reindeer sleds as a means of herding reindeer. Unfortunately, the noise and smell of the machines drove the reindeer into a wild state. The friendly relationships between the Lapps and their animals were disrupted by the high-speed machines. Frightened running by the reindeer decreased the number of reindeer calves born each year. The average number of reindeer per household in Sevettigärvi dropped from fifty-two in presnowmobile days to only twelve in 1971, a decade later. This average is misleading because about two thirds of the Lapp households completely dropped out of reindeer raising as a result of the snowmobile. Most could not find other work and became unemployed. On the other hand, one family, which was relatively early in purchasing a snowmobile, built up a large herd and by 1971 owned one third of all the reindeer in the community.

Not only did the frightened reindeer have fewer calves, but the precipitous drop in the number of reindeer also occurred because many of the animals had to be slaughtered for their meat in order to purchase the snowmobiles, gasoline for their operation, and spare parts and repairs. A new machine cost about $1,000, and gas and repairs typically cost about $425 per year. Despite this relatively high cost for the Skolt Lapps, who lived on a subsistence income, snowmobiles were considered a household necessity, and the motorized herding of reindeer was considered much more prestigious than herding by skis or with reindeer sleds. The snowmobile revolution pushed the Skolt Lapps into a tailspin of cash dependency, debt, and unemployment.

Why didn't the Lapps, given their love for the reindeer and the disastrous effects of snowmobiles, resist this technological innovation? Pelto (1973) suggests that the reason is that at no point in the diffusion of snowmobiles could they have predicted the possible future outcomes of the technology. An assessment of the technology's impacts could have been made in the 1960s, but it was not, because the Lapps were not technically able to anticipate the far-reaching consequences of the snowmobile. Further, Lapp society is very individualistic, and, given the technology's advantages for the first adopters (who were wealthier and younger than the average), initial adoption was impossible to prevent. Thereafter, the diffusion process quickly ran its course.

As a result, the reindeer-centered culture of the Skolt Lapps was severely disrupted. Most families today are unemployed and dependent on the Finnish government for subsistence payments. The snowmobile revolution in the Arctic led to disastrous consequences for the reindeer and for the Lapps who depended on the animals for their livelihood.

Since the anthropological study of the snowmobile revolution by Pertti Pelto, further technological developments have occurred in Lapland. During the summer months, the Lapps began using motorcycles to herd their reindeer. Certain affluent Lapps even began using helicopters. An increasing number of reindeer that are slaughtered for meat have been found to have stomach ulcers.

Technological innovation certainly has not been kind to the Skolt Lapps.

Studying Consequences

Instead of asking, as much past diffusion research has done—"What variables are related to innovativeness?"—future investigations need to ask, "What are the *effects* of adopting innovations?" Innovativeness, the main dependent variable in much past diffusion research, now becomes a predictor of a more ultimate dependent variable, the consequences of innovation. Most past diffusion research stopped with an analysis of the *decision* to adopt a new idea, ignoring how this choice is implemented and with what consequences.

Why have there been so few studies of consequences?

1. *Change agencies, which often sponsor diffusion research, overemphasize adoption per se, tacitly assuming that the consequences of innovation-decisions will be positive.* Change agencies assume that an innovation is needed by their clients, that its introduction will be desirable, and that adoption of the innovation represents "success." These pro-innovation assumptions are not always valid.
2. *The usual survey research methods are less appropriate for the investigation of innovation consequences than for studying innovativeness.* Extended observation over time, or an in-depth case study, are usually utilized to study consequences. Diffusion researchers have relied almost entirely upon survey methods of data gathering, ignoring the study of consequences, as the usual one-shot survey methods are inappropriate for investigating the effects of innovations. Unfortunately, case study approaches suffer in that they often yield idiosyncratic, descriptive data from which generalization to other innovations and other systems is difficult.

   The study of consequences is complicated by the fact that they usually occur over extended periods of time. An innovation's consequences cannot be understood simply by adding an additional question or two to a survey instrument, another hundred respondents to a sample population, or another few days of data gathering in the field. Instead, a long-range research approach must be taken in which consequences are analyzed as they unfold over a period of time, which may be several years. Professor Pelto, for example, returned to his Finnish village in Lapland for additional data gathering over many years.

   A panel study in which respondents are interviewed both before and after an innovation is introduced can thus yield information about consequences. Data about consequences can also be obtained from field experiments in which an innovation is introduced on a pilot basis and its results evaluated under realistic conditions, prior to its widespread diffusion. Panel studies and pilot field experiments can provide quantitative data about an innovation's consequences which can lead to generalizations, rather than mere description. Such generalizations can be predictive to a future point in time, rather than being just a postmortem of consequences that have already occurred. We draw upon several panel studies and field experiments in our following discussion of the equality consequences of innovations. Many past studies of consequences have been ethnographic analyses of a single community, often conducted by an anthropologist.
3. *Consequences are difficult to measure.* Individuals using an innovation are often not fully aware of all of the consequences of their adoption. Therefore, attempts to study consequences that rest on respondents' reports often lead to incomplete and misleading conclusions.

Judgments concerning consequences are almost unavoidably subjective and value-laden, regardless of who makes them. A researcher from one culture may find it difficult to make completely objective judgments about the desirability of an innovation in another country. *Cultural relativism* is the viewpoint that each culture should be judged in light of its own specific circumstances and needs. No culture is "best" in an absolute sense. Each culture works out its own set of norms, values, beliefs, and attitudes that function most effectively for its people. For instance, newcomers to India are often puzzled by the millions of sacred cows that roam the countryside freely, while many people suffer from hunger. A foreigner is unlikely to understand that Indian cattle provide manure, which is essential for fuel, fertilizer, and housing construction. The holiness of cows in the Hindu religion is in fact quite functional, rather than being just a cultural oddity.

Cultural relativism poses problems for the measurement of consequences. Data about the results of an externally introduced innovation that are gathered from clients, change agents, or scientific observers, are subjectively flavored by their cultural beliefs. Consequences should be judged as to their functionality in terms of the user's culture, without imposing outsiders' normative beliefs about the needs of the client system.

A further problem in measuring the consequences of an innovation is that they are often confounded with other effects. For example, in assessing the results of a new fertilizer or pesticide on crop yields, one cannot ignore the consequences caused by natural events such as droughts, floods, or volcanic eruptions. One problem in measuring the consequences of innovations is untangling cause-and-effect relationships. Ideally, we should only measure the consequences that are exclusively the outcome of the innovation, the changes that would not have occurred if the innovation had not been introduced. But many important consequences are unanticipated and indirect. These effects of an innovation are difficult to determine in a precise manner. For instance, the classification of unanticipated consequences relies on an investigator's ability to determine the original objectives for introducing an innovation in a system. These purposes may be partly concealed by subsequent rationalizations on the part of the members of the system.

Classification of Consequences

One step toward an improved understanding of the consequences of innovations is to classify them in a taxonomy. Consequences are not unidimensional. They can take many forms and are expressed in various ways. We find it useful to analyze three dimensions of consequences: (1) desirable versus undesirable, (2) direct versus indirect, and (3) anticipated versus unanticipated.

Desirable Versus Undesirable Consequences

Desirable consequences are the functional effects of an innovation for an individual or for a social system. *Undesirable consequences* are the dysfunctional effects of an innovation to an individual or to a social system. The determination of whether consequences are functional or dysfunctional depends on how the innovation affects the adopters. An innovation can cause consequences for individuals other than its adopters. For instance, rejecters of a new idea may be affected because an innovation benefits the other members of the system who adopt it, widening the socioeconomic gap between adopters and rejecters. Everyone in a system usually is touched by the consequences of a technological innovation, whether they are adopters or rejecters. An example is the Internet, which advantages certain individuals and disadvantages others through the digital divide, explained later in this chapter.

Certain innovations have undesirable impacts for almost everyone in a social system. The snowmobile in Lapland had ill consequences for almost everyone, although a few Lapps became very rich reindeer owners as a result of the innovation. Every social system has certain qualities that should not be destroyed if the system is to be maintained. These might include family bonds, respect for human life and property, maintenance of individual respect and dignity, and appreciation for others, including appreciation for contributions made by ancestors. Other sociocultural elements are more trivial and can be modified, discontinued, or supplanted with relatively less impact.

An innovation may be functional for a system but not functional for certain individuals in the system. The adoption of miracle varieties of rice and wheat in India and other nations in recent decades led to the Green Revolution. The resulting higher crop yields and farm incomes were important benefits for farmers, as were the lower consumer food prices for society. The Green Revolution also led to a reduction in the number of farmers, migration to urban slums, higher unemployment rates, and, in some countries, political instability. Although many individuals profited from the adoption of the new seeds, the Green Revolution led to unequal conditions for the system as a whole. So whether the consequences are desirable or undesirable depends on whether one takes certain individuals, or the entire system, as a point of reference.

WINDFALL PROFITS Positive consequences of an innovation may occur for certain members of a system at the expense of others. By the time laggards adopt a new idea, they are often forced to do so by economic pressures. By being the first in the field, innovators frequently secure a kind of economic gain called windfall profits.

Windfall profits are a special advantage earned by the first adopters of a new idea in a system. Their unit costs are usually lower, and their additions to total production have little effect on the selling price of the product. But when all members of a system adopt a new idea, total production increases, and the price of the product or service eventually drops.

An innovator must take risks in order to earn windfall profits. Not all new ideas turn out successfully, and occasionally the innovator gets his or her fingers burned. Adoption of a noneconomic or unsuccessful innovation can result in "windfall losses" for the first individuals to

adopt. An example of windfall losses occurred in the diffusion of pocket calculators. The first model, sold in 1971, measured three by five inches, cost $249 and could only add, subtract, multiply, and divide. Within a year, the price of a four-function calculator dropped to $100; in another year the price was only $50; and within a decade the calculator cost less than $10. Its size shrank to the thickness of a credit card. In this case, *later* adopters gained a windfall benefit by waiting to adopt.

Similarly, the author purchased a new VCR in 1980 for $2,000. Innovators who adopted so early suffered windfall losses when the selling price dropped to $100 for a VCR by 1990. Furthermore, the author's VCR was a Sony Betamax, which was replaced by another standard by the mid-1980s. It does not always pay to be an innovator!

Usually new ideas make the rich richer and the poor poorer, widening the socioeconomic gap between the earlier and later adopters of a new idea. Data from the Iowa hybrid seed corn study by Gross (1942) were reanalyzed by Rogers (1962). The innovators of this new idea, who adopted in the late 1920s, earned almost $2,500 more than the laggards, who adopted hybrid seed in 1941. The innovators earned windfall profits because of (1) a higher market price for corn that lasted only until most of the farmers adopted hybrid seed, thus increasing corn production, (2) their larger corn acreage (for example, the innovators who adopted in 1927, averaged 124 acres of corn while the typical laggard, who adopted in 1941, raised only 70 acres of corn), and (3) the greater number of years they received the higher yields from hybrid seed.

SEPARATION OF DESIRABLE AND UNDESIRABLE CONSEQUENCES Most innovations cause both desirable and undesirable consequences. Understandably, individuals generally want to obtain the functional effects of an innovation and to avoid the dysfunctional effects. Doing so assumes that certain of the desired consequences from a technological innovation can be separated from the consequences that are not wanted. Such an assumption of separation usually involves desired advantages of a new technology, such as increased effectiveness, efficiency, or convenience, versus such unwanted consequences as changes in social values and institutions. Previously, we discussed the desired advantage of the snowmobile among the Finnish Lapps (more rapid transportation), which unfortunately brought with it a steep decline in the reindeer population, widespread unemployment, and other social problems.

We conclude with Generalization 11-1: *The effects of an innovation usually cannot be managed so as to separate the desirable from the undesirable consequences.*

As discussed in Chapter 7, the Old Order Amish in the United States have maintained a distinctive culture for hundreds of years. The Amish do not adopt technological innovations such as cars and tractors, electricity, and household conveniences because the consequences of these innovations would contribute to the breakdown of their society. The Amish understand the principle of inseparability in managing technological innovations. They willingly forgo the advantages of tractors and modern farm equipment (such as larger farms, higher crop yields, and increased income) in order to avoid the undesirable consequences of increased dependence on non-Amish businesses (such as farm machinery dealers), lessened farm labor requirements, and the pressure for larger-sized farms.

The largest Amish community in the United States is located in Lancaster County, Pennsylvania, where this religious sect has survived for more than two hundred years by following the general rule of not adopting technological innovations. The fertile soil allows the Amish to succeed financially on small-sized farms of about 50 acres, which they operate on a labor-intensive basis. Their high fertility provides the workforce, so that mechanized equipment is not needed. Skyrocketing land prices, however, have made it difficult for Amish parents to set up their grown children in farming in recent years. When the young people enter urban occupations such as carpentry and construction work, they often drop out of Amish society. So the Old Order Amish in Lancaster County today face an uncertain future.

But the Amish adherence to the principle of inseparability has served them well. They forego most modern technological innovations in farming and household living because they fear the social consequences that would inevitably accompany them.

Direct Versus Indirect Consequences

The intricate and often invisible web of interrelationships among the elements of a culture means that a change in one part of a system often initiates a chain reaction of indirect consequences stemming from the direct consequences of an innovation. *Direct consequences* are the changes to an individual or a social system that occur in immediate response to adoption of an innovation. *Indirect consequences* are the

changes to an individual or a social system that occur as a result of the direct consequences of an innovation. These are consequences of consequences.

An illustration of the direct and indirect consequences of an innovation is provided by an anthropological study of the adoption of wet rice farming by a tribe in Madagascar (Linton and Kardiner, 1952). The nomadic tribe had cultivated rice by dryland methods. After each harvest they would move to a different location in a kind of slash-and-burn agriculture. Then they changed to wetland (irrigated) rice farming. A pattern of land ownership developed, social status differences appeared, the nuclear family replaced the extended clan, and tribal government changed. The consequences of the technological innovation were both direct and far-reaching, in that several generations of indirect consequences from wet rice growing spread from the more direct results.

ORT: The Consequences of Consequences

Until the 1980s, an estimated 5 million young children died each year from diarrhea-related causes, representing about 30 percent of all infant deaths in the world. Diarrhea is often caused by contaminated water due to inadequate sanitation and personal hygiene. In babies, diarrhea can cause a 10 percent loss of body weight, which, in a matter of hours, can lead to the baby's death due to dehydration.

Powdered milk–based baby formulas such as Nestlé's Lactogen contributed to infant deaths due to diarrhea because the powdered formula was not used as directed. During the 1980s, widespread public alarm and the actions of the World Health Organization (WHO) helped to convince Nestlé and other powdered milk baby formula manufacturers to change their marketing practices. Social marketing campaigns were launched in Latin America, Africa, and Asia to promote breast-feeding, and to discourage the use of powdered formulas for babies (see Chapter 9).

The most promising breakthrough in the struggle to prevent deaths due to infant diarrhea occurred when a young medical doctor in Bangladesh invented oral rehydration therapy (ORT). Despite its elegant scientific name the recipe for ORT is remarkably simple: add one bottle cap of salt and eight bottle caps of sugar to three soft drink bottles of clean water. Salt and sugar are available in every peasant household in the Third World. In a pilot project in The Gambia in West Africa, parents were instructed to measure the salt and sugar with a bottle cap from an empty Coke bottle and then to mix the ingredients in the bottle. ORT is essentially Gatorade without the green color. It is also similar to the chicken soup given to sick children by Jewish mothers. ORT is an electrolyte mixture that functions to rehydrate the body (that is, to return water to the body so that a baby does not die from dehydration) and provide lost salt. The sugar provides quick energy to help the body recover from dehydration.

ORT is a lifesaver, but it can also be dangerous. If the ratio of salt to sugar is accidentally reversed, the baby may die. If clean water is not used, the baby gets diarrhea again. ORT does not cure the bacteria that cause diarrhea. ORT only prevents the progression from diarrhea to dehydration to death. Can the correct mixing of the ORT formula be taught through the mass media? In the first ORT campaigns, conducted in Honduras and The Gambia, a poster illustrating the correct mixing of the ORT formula was designed without words (because of widespread illiteracy on the part of the intended audience). Salt and sugar look alike, and formative research on the poster showed that misunderstanding sometimes occurred. Some national ORT programs decided that it was more effective to distribute small foil packets of the salt and sugar, which were then mixed with water and given to the sick baby. These ORT packets were sold for a few cents in groceries or distributed free in government health clinics.

The results of the early ORT campaigns in Honduras and The Gambia indicated that certain traditional beliefs about infant diarrhea would have to be considered if ORT were to diffuse widely and be used effectively. In Honduras, for example, the traditional "cure" for diarrhea was to administer a purge (similar to Ex-Lax). Furthermore, it was widely believed that a sack of worms exists in everyone's abdominal cavity, and that when the worms become agitated and leave the sack, diarrhea results. So the prevention of infant diarrhea depended on not disturbing the sack of worms. Many people in The Gambia believed that infant diarrhea was caused by supernatural forces or by the will of Allah. The concept of dehydration ran counter to these traditional beliefs. Pilot social marketing of ORT in The Gambia and Honduras indicated that a communication campaign could raise the levels of public knowledge and adoption of ORT, but it was much more difficult to convey the concept of dehydration effectively. Most people who used ORT did not have a scientifically correct understanding of how it worked, as such principles-knowledge rests on understanding the chemical process of electrolytes. Health officials asked the rhetorical question "Does one need to know how a motor works in order to drive a car?"

By the mid-1990s, almost every developing nation in Latin America, Africa, and Asia had launched an effective ORT campaign. Integrated child survival campaigns typically emphasize ORT along with breast-feeding, immunization of children, improving the quality of drinking water, and better personal sanitation (such as using latrines and washing one's hands regularly).

As ORT diffused widely in Third World countries during the late 1980s and early 1990s, the rate of infant mortality dropped and the populations of these nations climbed. How were schooling, housing, and jobs to be provided for the millions of infants whose lives were saved by ORT? One answer was a faster rate of adoption of family-planning methods. But in many of the poorest countries where the ORT campaigns had been highly successful, national family-planning programs were relatively ineffective. The beneficial consequences of the rapid adoption of one innovation led to the worsening of another social problem.

The diffusion of ORT suggests that the indirect consequences of an innovation are often especially difficult to plan for, and manage, as they are often unanticipated.

Anticipated Versus Unanticipated Consequences

Anticipated consequences are changes due to an innovation that are recognized and intended by the members of a social system. An example of such a manifest consequence is the snowmobiles' advantage to the Lapps of providing rapid transportation. The Lapps could not, however, anticipate such latent consequences of this innovation as its disastrous effects on their reindeer herds. Although they are less discernible to observers, the "subsurface" consequences of an innovation may be just as important as the anticipated consequences.

Unanticipated consequences are changes due to an innovation that are neither intended nor recognized by the members of a social system. The disintegration of respect for elders among the Yir Yoront, in the case study that follows, is an example of an unanticipated consequence of the adoption of steel axes by Australian aborigines. This change in family relationships was of tremendous importance to the tribe, even though such a consequence was not readily apparent when steel axes were first introduced by well-meaning missionaries.

No innovation comes without strings attached. The more technologically advanced an innovation, the more likely its introduction will produce many consequences, both anticipated and latent. A system is like a bowl of marbles: move any one of its elements, and the positions of all the others inevitably change also.

This interdependency of the elements in a system is poorly understood by the adopters of an innovation, and may not even be comprehended by the change agents who introduce a new idea in a system. Unanticipated consequences represent a lack of understanding of how an innovation functions, and of the internal and external forces at work in a social system. Awareness of a new idea creates uncertainly about how the innovation will actually function for an individual or other adopting unit in a system. This uncertainty motivates active information seeking about the innovation, especially through interpersonal peer networks. Individuals particularly seek to reduce uncertainty concerning an innovation's expected consequences. Such uncertainty can be decreased to the point where an individual feels well informed enough to adopt the new idea. But uncertainty about an innovation's consequences can never be completely removed.

An adopter is often able to obtain adequate information from peers about the desirable, direct, and anticipated consequences of an innovation. But the unanticipated consequences are, by definition, unknown by individuals at the time of adoption of the innovation. Such unforeseen impacts of a new idea represent innovation-evaluation information that cannot be obtained by an individual from other members of his or her system. Professional change agents often cannot know the unanticipated consequences of an innovation until after its widespread adoption has occurred (if then), as we see in the following case of the steel ax, introduced by missionaries to an isolated Australian tribe.

We conclude this discussion of the three classifications of consequences with Generalization 11-2: *The undesirable, indirect, and unanticipated consequences of an innovation usually go together, as do the desirable, direct, and anticipated consequences.*

*Steel Axes for Stone-Age Aborigines**

The consequences of the adoption of steel axes by a tribe of Australian aborigines vividly illustrate the need for consideration of the undesirable, indirect, and unanticipated consequences of an innovation (this case was mentioned previously, in Chapters 1 and 2). The Yir Yoront traveled in small nomadic groups over a vast territory in search of game and other food. The central tool in their

*This case illustration is adopted from Sharp (1952, pp. 69–92).

culture was the stone ax, which they found indispensable for food production, constructing shelter, and heating their homes. A complete revolution was precipitated by the replacement of the stone ax by the steel ax.

Anthropologist Lauriston Sharp (1952) conducted an investigation of the Yir Yoront by the method of participant observation. He studied Yir Yoront culture by taking part in its everyday activities. Because of its isolation, the tribe was relatively unaffected by Western civilization until the establishment of a nearby missionary post. The missionaries distributed many steel axes among the Yir Yoront as gifts and as payment for work performed.

Previously, the stone ax had been a symbol of masculinity and respect for elders. Only men owned stone axes, although women and children were the principal users of these tools. Axes were borrowed from fathers, husbands, or uncles according to a system of social relationships prescribed by custom. The Yir Yoront obtained their stone ax heads in exchange for spears through bartering with other tribes, a process that took place as part of elaborate rituals at seasonal fiestas.

When the missionaries distributed the steel axes to the Yir Yoront, they hoped that a rapid improvement in living conditions would result. There was no great resistance to using the steel axes, because the tribe was accustomed to securing their tools through trade. Steel axes were more efficient for most tasks, and stone axes rapidly disappeared.

However, to the disappointment of the missionaries, the steel ax contributed little to social progress. The Yir Yoront used their new-found leisure time for sleep, "an act they had thoroughly mastered." The missionaries distributed the steel axes equally to men, women, and children. Young men were more likely to adopt the new tools than were the elders, who did not trust the missionaries. The result was a disruption of status relationships among the Yir Yoront and a revolutionary confusion of age and sex roles. Elders, once highly respected, now became dependent upon women and younger men and were often forced to borrow steel axes from these social inferiors.

The trading rituals of the tribe also became disorganized. Friendship ties among traders broke down, and interest declined in the annual fiestas, where the barter of stone axes for spears had formerly taken place. The religious system and social organization of the Yir Yoront became disorganized as a result of the tribe's inability to adjust to the innovation. To the horror of the missionaries, the men began prostituting their daughters and wives in exchange for the use of other people's steel axes.

Many of the consequences of the innovation among the Yir Yoront were undesirable, indirect, and unanticipated. These three types of consequences often go together, just as desirable, direct, and anticipated consequences are often associated.

Form, Function, and Meaning of an Innovation

The case of the steel ax among the Yir Yoront also illustrates a common error made by change agents in regard to an innovation's consequences. They usually are able to anticipate the form and function of an innovation's consequences, but not its meaning for potential adopters. What are the form, function, and meaning of an innovation?

1. *Form* is the directly observable physical appearance and substance of an innovation. Both the missionaries and the Yir Yoront recognized the form of the new tool because of its similarity in appearance to the stone ax.
2. *Function* is the contribution made by an innovation to the way of life of members of a social system. The tribe immediately perceived the steel ax as a cutting tool, to be used in much the same way as the stone ax had been.
3. *Meaning* is the subjective and frequently unconscious perception of an innovation by members of a social system. A famous anthropologist, Ralph Linton (1936), explained, "Because of its subjective nature, meaning is much less susceptible to diffusion than either form or [function]. . . . A receiving culture attaches new meanings to the borrowed elements of complexes, and these may have little relation to the meanings which the same elements carried in their original setting."

What mistakes did the missionaries make in the introduction of the steel ax? These change agents understood the form and function of the steel ax. They believed the Yir Yoront would use the new tool in much the same way as they had the stone ax, such as for cutting brush. But the missionaries made an egregious error in not predicting the meaning of the new idea for the Yir Yoront. They did not anticipate that the steel ax would lead to more sleep, prostitution, and a breakdown of social relationships. Change agents frequently do not sense or understand the social meaning of the innovations that they introduce, especially the negative consequences that accrue when an apparently desirable innovation is used under different conditions. Change agents are especially likely to make this mistake if they do not empathize with the innovation's users, which is particularly likely when the change agents are heterophilous with their clients.

We conclude with Generalization 11-3: *Change agents more easily anticipate the form and function of an innovation for their clients than its meaning.*

*The Irish Potato Famine**

One of the worst famines in history was the Irish potato famine of 1850, which left at least one million people dead of starvation, forced another 2 million to migrate to the United States, and left several million to live in abject poverty. What caused this famine?

The story begins a century earlier, when a new wonder food, the potato, was introduced from North America. Ireland's climate was perfect for potato growing, and Ireland was relatively free from potato diseases and insects. Potato yields were abundant. The population began to increase, from 2 million Irish in the 1700s to 4.5 million by 1800, and then to 8 million in 1845. Catholic priests blessed this increased human fertility, which gave them more souls to save. Thanks to the potato, the human population continued to expand. Absentee landlords who visited their estates were amazed at the hordes of dirty, wretched people living in absolute poverty. Even with the prospering potato, most Irish lived on the edge of hunger.

Then in 1845, a fungus, *Phytophthora infestans,* arrived from America and wiped out the entire potato crop. Previously, during the long Atlantic crossing, often requiring a month or more, infected potatoes being carried to feed passengers had rotted, and the fungus had died. But the new clipper ships made the transatlantic crossing so quickly, in twelve to fourteen days, that infected potatoes did not have time to rot and the fungus survived the trip. The weather in 1845 and 1846 was cool and rainy, perfect for rapid spread of the fungus.

Who or what was responsible for the devastating Irish potato famine in Ireland? Was it the unwitting do-gooder who first brought the potato to Ireland? Was it the fungus? Was it the improved sailing technology of the clipper ships, which shortened the trans-Atlantic crossing, allowing the fungus to arrive on Irish shores? Or was it the Catholic religion of the Irish, which favored large families?

*This case illustration is based on Paddock (1992).

Achieving a Dynamic Equilibrium

Perhaps the missionaries introduced too many steel axes to the Yir Yoront too rapidly. What rate of change allows a system to achieve the maximum benefits of an innovation and yet not produce disequilibrium in the social system?

Three types of equilibrium are possible in a system:

1. *Stable equilibrium,* which occurs when there is almost no change in the structure or functioning of a social system. An example of stable equilibrium is a completely isolated and traditional system in which the rate of change is almost zero, perhaps something like the Yir Yoront before the arrival of the missionaries.
2. *Dynamic equilibrium,* which occurs when the rate of change in a social system occurs at a rate that is commensurate with the system's ability to cope with it. Change occurs in a system in dynamic equilibrium, but it occurs at a rate that allows the system to adapt to it.
3. *Disequilibrium,* which occurs when the rate of change is too rapid to permit a social system to adjust. An analogy is a traffic circle with one too many cars on it; the circulation of vehicles slows down until eventually all movement stops. The social disorganization that accompanies disequilibrium makes it a painful and inefficient way for change to occur in a system.

The long-range goal of most change agents is to produce a condition of dynamic equilibrium in their client system. Innovations should be introduced into the system at a deliberate rate that allows for careful balancing of the system's ability to adjust to the changes. Gauging the optimum rate of change in a system is difficult. The missionaries among the Yir Yoront misjudged the rate at which the aborigines' system could absorb the consequences of the steel ax.

*The Mosquito Killer**

Dichlorodiphenyltrichloroethane (DDT) was one of the important health innovations of the past century, saving the lives of millions of people by protecting them against malaria-carrying mosquitos. This chemical was discovered by a Swiss chemist, Paul Müller, in the late 1930s, while he was looking for a means to protect woolens against moths. Later, in 1948, Müller was awarded the Nobel Prize for his discovery. But for many years, practical uses for DDT were not found. Early in World War II in the Pacific, malaria transmitted by mosquitos was handicapping the fighting ability of U.S. military personnel. For example, 10,000 of the 17,000 men in the First Marine

*This case illustration is adapted from Gladwell (2001) and Speilman and D'Antonio (2001).

Division were incapacitated by malarial headaches, fevers, and chills and had to be withdrawn from island fighting against the Japanese.

Anyone who has ever had malaria will never forget the raging thirst, headaches, and bone-breaking pain. The word "malaria" comes from the Italian for "bad air." Only about a century ago, it was determined that the malaria parasite was carried by mosquitos, who infected humans by biting them to suck blood.

In 1943, DDT was being tested at an Army laboratory in Orlando, Florida. One of two duck ponds was doused with DDT, and all the mosquito larvae in this lake promptly died. But a week later, mysteriously, the larvae in the other duck pond, several miles distant, also died. Ducks from the treated pond had visited the second pond, and there was enough DDT residual on their feathers to kill the mosquito larvae. Clearly, here was a very powerful insecticide! DDT was rushed into use in the Pacific War. Dengue fever, borne by the *Aedes* mosquito, was sickening five hundred men a day in the invasion of Saipan. A DDT air strike was made on the island. The dengue fever promptly subsided, and the Marines were victorious. The capture of Saipan was important in the Pacific war, as this island provided the air base from which the *Enola Gay* dropped the atomic bomb on Hiroshima in 1945.

DDT also proved to be the perfect killer of the *Anopheles* mosquito, the main carrier of malaria. In the 1940s, malaria was a major public health problem worldwide. In India alone, 75 million people were infected with malaria, and the disease killed 800,000 people each year. Malaria was found throughout Europe, Asia, the Caribbean, and the American South. Leading the DDT attack on mosquitos was Dr. Fred Soper, who had his doctorate from the Johns Hopkins School of Public Health and worked for the Rockefeller Foundation, then leading efforts to improve health around the world. Soper was "the General Patton of entomology" (Gladwell, 2001, p. 44). His disciplined approach to mosquito eradication began with mapping the area to be cleared of mosquitos and then numbering each house. Each house was assigned to a sector, which in turn was assigned to an inspector with a spray pump filled with insecticide. The walls and ceiling of each house were sprayed, as the mosquitos would alight there before and after biting people living in the house. The DDT coating on the home's surface killed all mosquitos on contact for a period of six months or more.

Each inspector's daily work was checked by a supervisor, who was given a bonus if he found a mosquito that the spray man had missed. The spray man was docked a day's pay. Soper was a tough boss, completely devoted to eradicating the mosquito. On one occasion, a large ammunition dump near Rio de Janeiro exploded. Soper heard the explosion, checked his map, and noted that an inspector was spraying that area. Soper immediately sent condolences and a check to the widow. The next day, the inspector surprised everyone by showing up for work. Soper fired him on the spot—for being alive and having shirked his duties as a spray man.

The most dangerous of the sixty species of *Anopheles* mosquito in transmitting the malaria parasite to humans is the *gambiae,* which is native to Africa. Unfortunately, this species was carried across the Atlantic by ships, and soon 18,000 square miles of Brazilian coastal areas were infected. Soper and his army of 4,000 sprayer-inspectors eradicated the *gambiae* in one year. Initially, Soper's antimosquito army used a spray called Paris green (copper acetarsenite). When he learned of DDT in 1943, Soper wrote in his diary, "Malaria results (for DDT) ARE FANTASTIC" (quoted in Gladwell, 2001, p. 46). He soon launched an attack on malaria-carrying mosquitos on the large island of Sardinia in the Mediterranean, which had the most serious malaria epidemic in Italy. Soper trained a cadre of 25,000 inspectors and supervisors. At the end of a five-year spraying campaign, in which 256 tons of DDT were dusted onto the island, the number of malaria cases in Sardinia dropped from 10,000 annually to just four in 1950!

With this success behind him, Soper set out to eradicate malaria-carrying mosquitos worldwide. In league with other malariologists, he convinced the World Health Organization (WHO) to establish a Global Malaria Eradication Programme, with the goal of killing mosquitos in every nation. The enthusiastic goal of the WHO program was to eliminate the *Anopheles* mosquito, and hence malaria. In Taiwan, much of the South Pacific, North Africa, Sri Lanka, the Balkans, and Australia, the campaign was a success. In India, malaria fatalities dropped to zero by the early 1960s. Millions, perhaps tens of millions, of lives were saved by Soper's DDT sprayers. Perhaps no other man-made drug or chemical has saved more lives.

Soon, however, problems arose in Soper's war on the mosquito. In the late 1940s, a malariologist observed a healthy mosquito flying around a room that had been heavily sprayed with DDT. How could this incredible event have happened? DDT attacks a mosquito's nervous system, sending it into a lurching, twitching spasm before it dies. But due to random genetic mutation, a few mosquitos in every large population are resistant to DDT. Perhaps the insecticide does not bind to the mosquito's nerve endings because the mosquito has a thicker skin. Resistant mosquitos then continue to breed, while other mosquitos are killed by DDT, and soon entire new generations are DDT-resistant. Another type of protection from the DDT spraying of walls and ceilings occurred among a type of mosquitos in the Solomon Islands. These mosquitos did not alight on the walls or ceilings of homes; instead, they flew in through a window, bit a human, and then flew back out.

The development of DDT-resistant mosquitos came as a great shock to Soper and his fellow mosquito killers. After some years, countries that had been enthusiastic allies of Soper began to cancel their eradication campaigns. In 1969, WHO dropped its Global Eradication Programme. Soper toured Asia, and was appalled at what he observed. Everywhere mosquitos, and malaria, were on the increase. Soper blamed these defeats on a lack of discipline in the DDT-spraying campaigns. Some labeled him a "disease fascist." Soper advocated heavier and heavier doses of DDT, but in areas with the heaviest spraying, the resistant mosquitos especially flourished. Soper's dream of a world free of malaria was rapidly unraveling. Then Rachel Carson's bombshell book *Silent Spring* was published in 1962, arguing that DDT was being used without concern for its environmental consequences. Once the world set foot on the treadmill of DDT spraying, Carson claimed, it was unable to get off. The U.S. Environmental Protection Agency banned the general use of DDT in the United States in 1972. "DDT is a prisoner of politics and may never escape" (Spielman and D'Antonio, 2001, p. 204).

Fred Soper was an absolutist, a fanatic, who believed that DDT spraying was *the* way to prevent malaria. He scoffed at experts who argued that draining the breeding areas of the mosquitos should accompany the spraying and that DDT should be used sparingly and as only one of several tools in a malaria eradication campaign. Standing ramrod straight and always dressed in a suit, Fred Soper learned the hard way that even dramatically effective technological innovations can have perverse consequences. When Soper died in 1975, he was viewed as an enemy by environmentalists. But to the many millions of people whose lives had been saved by his actions, Soper was a hero.

Equality in the Consequences of Innovations

A specific mistake made by the missionaries among the Yir Yoront was their choice of people to whom they introduced the innovation. Unaware of the cultural emphasis on respect for elderly males, the change agents indiscriminately gave steel axes to women, children, and young men. One of the ways in which change agents shape the consequences of an innovation is who they work with most closely. If a change agent were to contact the poorer and less educated individuals in a social system, rather than the socioeconomic elites (as is usually the case), the benefits from the innovations that are so introduced would be more equal. Usually, however, change agents have most contact with the better-educated, higher-status individuals in a system, and thus tend to widen socioeconomic gaps through the innovations that they introduce.

In addition to the desirable/undesirable, direct/indirect, and anticipated/unanticipated aspects of the consequences of innovation (discussed earlier), one might classify consequences as to whether they increase or decrease equality among the members of a social system.

The diffusion of innovations generally causes wider socioeconomic gaps within an audience because:

1. Innovators and early adopters have favorable attitudes toward new ideas and more actively search for innovations. They also possess more resources and thus can adopt higher-cost innovations that later adopters cannot afford.
2. Professional change agents concentrate their client contacts on innovators and early adopters in hopes that the opinion leaders among these earlier adopting categories will then pass along the new ideas they have learned to their followers. But most interpersonal network links connect individuals who are similar in adopter category and socioeconomic status. So innovations generally trickle *across,* rather than *down,* in the interpersonal communication networks of a system.
3. By adopting innovations relatively sooner than others in their system, innovators and early adopters achieve windfall profits, thereby widening the socioeconomic gap between these earlier adopting categories versus later adopting categories. Thus the earlier adopters get richer, and the later adopters' economic gain is comparatively less.

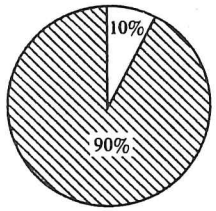
The diffusion of innovations usually decreases the degree of equality in a social system. But this tendency toward gap-widening need not occur, if special strategies are followed to narrow gaps. The previous example of the impact of the snowmobile on the Skolt Lapps, illustrated two dimensions of consequences: (1) the first dimension of helping everyone travel more rapidly (thus achieving a higher average *level* of "Good," some widely desired objective) and (2) the second dimension of the *unequal distribution* of the "Good," the tendency for reindeer ownership to become concentrated in the hands of just a few Lapps (Figure 11-1).

The Communication Effects Gap

Most past diffusion studies attempted to determine the first dimension of communication effects by pursuing the question "What are the effects of a communication activity to diffuse an innovation?" These

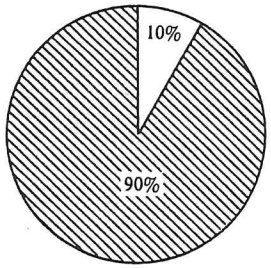
Figure 11-1. The Two Dimensions of Consequences of an Innovation in a System: (1) the Level of Good (above), and (2) the Degree of Equality (below)

1. Before the Innovation



The total amount of income or other Good in the system is held by a wealthy minority (of, say, 10 percent)

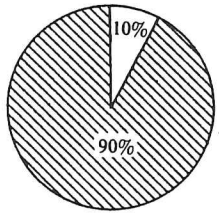
2. After the Innovation



The total amount of Good is now larger, but the proportion held by the wealthy minority remains the same.

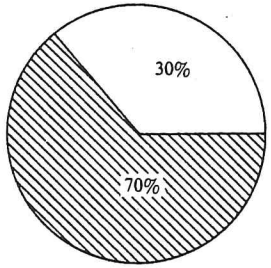
I. The level of Good in a system increases, but its distribution remains at the same degree of equality-inequality.

1. Before the Innovation



The prior conditions are the same as above.

2. After the Innovation



Both the total amount of Good in the system and the proportion of Good held by the wealthy increase as a consequence of the innovation. Hence there is less equality.

II. The level of Good in a system increases, and its distribution becomes more concentrated and hence less equal.

effects are measured as the average change in the knowledge, attitudes, or overt behavior (that is, adoption) regarding an innovation by a set of individuals (Figure 11-2*a*).

Research on the second dimension of communication effects is quite different (Figure 11-2*b*). Here one asks, "Has the communication

Figure 11-2a. The First Dimension of Communication Effects (for All Members of the System) Is an Average Increase of Four Units, Measured as the Difference from t_1 to t_2.

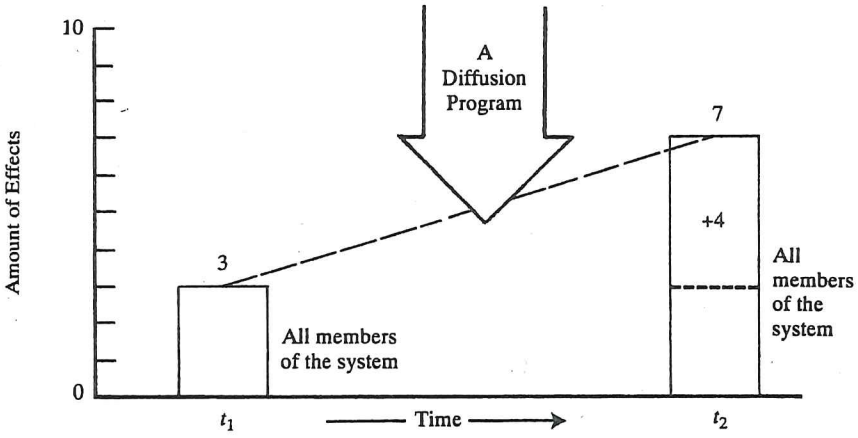
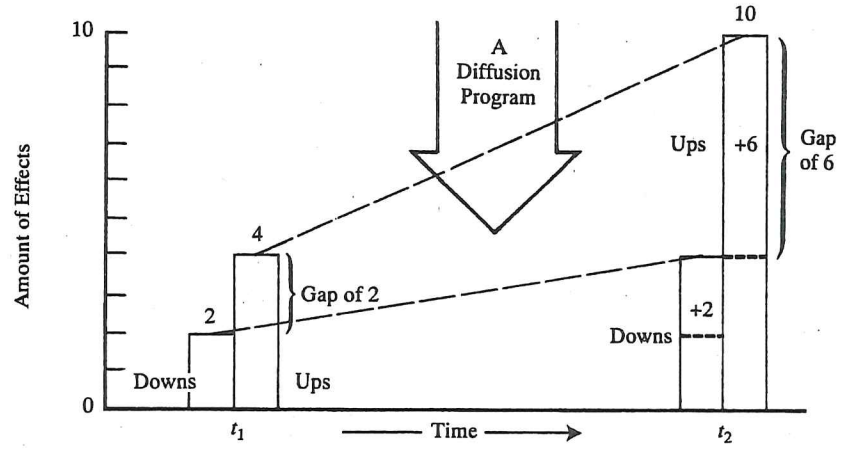


Figure 11-2b. The Second Dimension of Communication Effects (Which Analyzes Effects Separately for Downs and Ups) Indicates That the Effects Gap Is Widened by the Diffusion Program.



Note that the Downs are *absolutely* better off as a result of the diffusion intervention (+2), but *relatively* worse off (as the Ups gained +6). So the information-rich got richer, and the information-poor got less poor.

activity to diffuse an innovation had a greater, or different, effect on certain individuals, rather than on others?" The investigator seeks to ascertain the *equality* of effects of communication, not just how much effect occurred *on the average* (or in the aggregate).

About the time that diffusion researchers became interested in this second dimension, dealing with the equality issue, Tichenor and colleagues (1970) proposed a useful research paradigm for studying gaps, suggesting that data should be gathered at two or more points in time, both before and after a diffusion intervention. The measure of effects should be not just the average amount of behavior change in the audience (the first dimension) but whether gaps in socioeconomic status and/or in knowledge of information increased or decreased (this is the second dimension of effects). In essence, Tichenor and colleagues (1970) suggested that we should look at who in an audience was affected most and who least. Figures 11-2*a* and 11-2*b* depict this research paradigm, which was very influential on diffusion scholars studying the equality of consequences of innovation.

A main implication of the communication effects gap paradigm, inspired by Tichenor and colleagues (1970) and carried forward in numerous other studies (Viswanath and Finnegan, 1996), was to look *within* an audience to determine whether certain segments were more affected by an innovation's diffusion than were other segments. This analytic approach looked for differential effects, rather than just for average effects or aggregate effects on the entire audience. Scholars began to investigate the degree to which a diffusion program widened or narrowed gaps among the members of a system. The categorization of an audience into two or more segments (who might be called the "ups" and "downs") could be on the basis of socioeconomic status (for example, larger versus smaller businesses in an industry), adopter category (for instance, earlier adopters versus later adopters), or the level of information that individuals possessed (the information-rich versus the information-poor). Almost no matter how the "ups" and "downs" are classified, certain regularities about equality and inequality in the consequences of diffusion are found.

Gap-Widening Consequences of the Diffusion of Innovations

Generalization 11-4 states: *The consequences of the diffusion of innovations usually widen the socioeconomic gap between the earlier and later adopting categories in a system.* A second, related conclusion, Generalization 11-5, is: *The consequences of the diffusion of innovation usually widen the socioeconomic gap between the audience segments previously high and low in socioeconomic status.*

Havens and Flinn (1974) examined the consequences of new coffee varieties among Colombian farmers over the period from 1963 to 1970. The community of study, Támesis, is located high in the Andes Mountains in the Department of Antioquia (later to become famous as the base of operations of the Medellín drug cartel). At the time of the Havens and Flinn (1974) study, however, the main source of income in this region of Colombia was coffee growing. The quality of the aromatic beans, grown on bushes covering the steep slopes of Antioquia, was excellent, and the coffee, marketed in the United States and elsewhere by Cafeteros, the Colombian Coffee Growers Association (whose logo is Juan Valdez and his donkey), received a top price. Coffee growing was a very profitable enterprise.

Of the original sample of fifty-six coffee growers in the study, seventeen adopted the new varieties, which considerably increased their yields. They adopted chemical fertilizers and herbicides along with the new coffee varieties in order to achieve these high yields. As a result of adopting this package of innovations, the seventeen adopters raised their net income from 6,700 pesos in 1963 to 21,000 pesos in 1970, an increase of 14,300 pesos (213 percent). The thirty nonadopting coffee farmers (who did not use the new coffee varieties) raised their net income from 4,500 pesos to 12,000 pesos, an increase of only half as much (7,500 pesos, or 166 percent). One effect of the coffee variety innovations was to widen the income gap between the adopters and nonadopters from 2,200 pesos in 1963 to 9,000 pesos in 1970. The improved coffee varieties caused much greater income inequality among Colombian farmers.

How much of this increased inequality among the Colombian coffee growers was due to the adoption of the new coffee varieties and how much to other factors, such as initially larger farms, higher formal education, and other characteristics of the adopters? Havens and Flinn (1974) computed the net income per acre of coffee grown, thus removing the effect of the larger-sized farms of the adopters. The adopters and nonadopters both began at about the same level of income per acre in 1963: 290 pesos per acre and 222 pesos per acre, respectively. But by 1970, when the adopters were enjoying the higher yields that resulted from growing the new varieties, their income per acre shot up to 1,642 pesos per acre (an increase of 1,352 pesos), while the nonadopters' income per acre rose to 632 pesos (an increase of 415 pesos). Much of the increased income inequality between the adopters and nonadopters

was due to the introduction of the coffee variety innovations. The results of the new coffee varieties in Colombia illustrates the communication effects gap (Generalization 11-4).

What did the adopters in Colombia do with their higher income? Some bought larger farms, often land sold by the unsuccessful nonadopters of the new coffee varieties. In 1963, the adopters averaged farms of 19 acres and the nonadopters 8 acres. By 1970, the adopters had increased the size of their farms to 33 acres, while the nonadopters' farms had shrunk to an average size of 6 acres. In addition, eleven of the nonadopters dropped out of farming and either became day laborers or else migrated to the city (presumably, their farms were purchased by adopters of the new coffee varieties).

If adoption of the new coffee varieties would have such important consequences, why didn't the thirty-nine nonadopters also start growing the new varieties? Adopting a new coffee variety is a major decision in Colombia because three years are required before the new trees produce. Many farmers needed credit to tide them over this period until their investment in the new variety began to pay off. Smaller *campesinos*, who did not have much land to put up as collateral, were generally unable to borrow funds to enable them to adopt the new coffee varieties. So Generalization 11-5, about widening the socioeconomic gap between those high and low in socioeconomic status, is also illustrated by the Colombian coffee varieties study.

This vicious circle explains how adoption of the coffee variety innovations widened the socioeconomic gaps between (1) adopters and nonadopters and (2) individuals originally high and low in socioeconomic status. The innovation was like a lever, widening the gap between the rich and the poor.

Social Structure and the Equality of Consequences

How an innovation is introduced determines, in part, the degree to which it causes unequal consequences. Evidence for this point comes from an investigation of the impacts of adopting irrigation wells by villagers in Bangladesh and in Pakistan (Gotsch, 1972). In each country, an irrigation well cost about the same amount and provided water for 50 to 80 acres of farmland. The introduction of Green Revolution wheat and rice varieties created a need for irrigation in both nations. But the equality of the consequences of an identical innovation was quite different in Pakistan from those in Bangladesh, mainly because of

the different social organization that accompanied the new technology.

In Pakistan, 70 percent of the irrigation wells were purchased by farmers with 25 acres or more (considered very large farms). Only 4 percent of the villagers with farms of less than 13 acres adopted. When the irrigation water was accompanied by the use of fertilizers and other agricultural chemicals, a farmer typically could increase his net farm income by about 45 percent. So the irrigation wells in Pakistan made the rich richer and the poor farmers *relatively* poorer.

However in Bangladesh, average farm size was only 1 or 2 acres, not large enough to justify private ownership of an irrigation well. So village cooperatives typically purchased a pump and well and provided irrigation water to everyone who belonged to the co-op. Incomes were doubled because farmers could raise a winter crop of rice during the season when rainfall was scarce. In Bangladesh, the rate of adoption of the wells was slower than in Pakistan because the innovation-decision was collective rather than individual-optional in nature. But the consequences of the innovation were distributed much more equally than they were in Pakistan, where an initially high degree of social stratification concentrated the impacts of the irrigation wells on the richer farmers.

The social structure in which the innovation of pump-well irrigation was introduced in Bangladesh and Pakistan, rather than the innovation itself, determined the distribution of its socioeconomic impacts. This investigation, along with others, suggests Generalization 11-6: *A system's social structure partly determines the equality versus inequality of an innovation's consequences.* When a system's structure is already very inequal, it is likely that when an innovation is introduced (especially if it is a relatively high-cost innovation), its consequences will lead to even greater inequality in the form of wider socioeconomic gaps.

The irrigation consequences research in Bangladesh and Pakistan illustrates, as does the Colombian coffee study, that an innovation's adoption and its impacts are related to characteristics of the social system, as well as to variables at the individual level of analysis. The fact that village co-ops already existed in Bangladesh when irrigation wells were introduced and that small coffee growers in Colombia could not obtain credit to adopt the new coffee varieties largely determined who adopted and who could not. The determining factors were mainly at the system level, although their impacts occurred through individuals' actions, and there were consequences for both individuals and the system.

Social structural factors are not necessarily static barriers or facilitators of the adoption of innovations and their consequences. A rural

development agency in Bangladesh had organized the village cooperatives just before the introduction of irrigation wells, for exactly the purpose that they served: to enable small farmers, through banding together, to adopt relatively high-cost innovations such as tractors and irrigation wells. Here we see again the potential power of organizing for social change, that a set of individuals, once organized in groups, can express a collective efficacy in achieving group actions that they could not attain as relatively powerless individuals.

Strategies for Narrowing Gaps

As the previous studies suggest, innovations do not inevitably widen socioeconomic gaps within a system. But such gap-widening inequality will usually occur unless a change agency devotes special efforts to prevent it. What strategies can be used by change agencies for gap narrowing? We list possible strategies here, organized under the major reasons why socioeconomic gaps ordinarily widen as a consequence of innovations.

I. "Ups" Have Greater Access to Information, Creating Awareness of Innovations, Than Do "Downs."

1. Messages that are redundant or that are of less interest and/or benefit to the higher socioeconomic subaudience should be provided. This strategy enables the lower-socioeconomic subaudience to catch up. This "ceiling effect" strategy was used for narrowing the socioeconomic gap among Indian villagers through special television programming (Shingi and Mody, 1976).
2. Communication messages should be tailored especially for the lower-socioeconomic subaudience in terms of their particular characteristics, such as formal education, beliefs, communication habits, and the like. Communication messages are seldom especially designed for this audience segment, and hence most messages are ineffective in closing gaps. Although the technical content of these messages may be the same as for the "ups," to be effective in reaching the lower socioeconomic audience, the design, treatment, and presentation of messages may have to be different. For example, more line drawings, photographs, and other visual aids are often needed because the "downs" have lower levels of formal education. Formative research* may help produce effective messages for the "downs," such as by testing prototype messages before they are produced in large quantities. For instance, content analyses show that most health-related Web sites on the World Wide Web require at least a high school education to comprehend (Berland et al., 2001). However, an effective Web site about improved nutrition for low-income rural Hispanic people in New Mexico was produced, using extensive formative research (Buller et al., 2001).
3. Communication channels that get through to "downs" should be utilized so that access is not a barrier to gaining awareness-knowledge of innovations. In the United States, for example, lower-socioeconomic audiences are especially heavy television viewers but depend less on print media than do "ups." In developing nations, many "downs" are not literate, so print media are useless. In these countries, "downs" are much more likely to be exposed to radio than to watch television.
4. "Downs" should be organized into small groups in which they can learn about innovations and discuss them. The group context for listening, discussion, and action provides a basis for the "downs" to gain self-efficacy and collective efficacy, a belief that they have control over their environment. This strategy is organizing for social change, mentioned previously.
5. Change agent contact should be shifted from the innovators and early adopters to the late majority and laggards. Later adopting categories tend to place less credibility in professional change agents, and they seldom actively seek information from them, as they place greater trust in interpersonal peer networks. But when change agents directly contact late majority and laggards, and if the innovations are appropriate to their needs, the response has often been encouraging (Röling et al., 1976).

   Consider the case of a change agent working in one village. One farmer owns 100 acres, while the remaining hundred farmers have an average of one acre each. If the change agent contacts the hundred smaller farmers, he or she may be able to persuade them

**Formative research* is investigation conducted while an activity, process, or system is ongoing, in order to improve its effectiveness. In contrast, *summative research* is investigation conducted in order to reach a decision about the effectiveness of an activity, process, or system after it has run its course.

to adopt new crop varieties and other agricultural innovations, so that their yields increase by an average of ten bushels per acre within five years. But with much less effort, the change agent can contact the farmer with the largest farm, who is already innovative and receptive to new ideas. The increase of ten bushels per acre on the elite individual's farm equals the consequences of the much greater efforts by the change agent with all one hundred smaller farmers. This illustration shows why change agent contact is generally concentrated on earlier adopters, and on individuals of higher social status.

II. "Ups" Have Greater Access to Innovation Evaluation Information from Peers than Do "Downs."

Trickle-down theory suggests that "downs" rapidly learn of the "ups'" personal experience with an innovation and follow suit. In many systems, however, "ups" talk primarily to "ups," and "downs" to "downs" (Röling et al., 1976). How can this problem be overcome?

1. Opinion leaders among the disadvantaged individuals in a system should be identified and change agent contact should be concentrated on them, to activate their peer networks about an innovation.
2. Change agent aides should be selected from among the "downs," who can contact their homophilous peers about innovations.
3. Groups should be formed among the "downs" to provide them with leadership and social reinforcement in their innovation decision making. Such small groups give the "downs" greater economic, political, and social strength (as in the example of the Bangladesh village cooperatives that adopted irrigation pump wells).

III. "Ups" Possess Greater Slack Resources for Adopting Innovations Than "Downs."

"Ups" can usually adopt innovations much more easily than "downs," particularly if these new ideas are expensive and technologically complex, and if they provide economies of scale. What strategies can overcome these gap-widening tendencies?

1. Appropriate innovations for "downs" should be recommended. R&D activities should be directed at the problems of the lower-socioeconomic members of a system to create these innovations.

2. A social organization should be created to allow "downs" to command the resources needed to adopt certain high-cost innovations. An illustration of this strategy of organizing for social change is the village co-ops in Bangladesh that facilitated the adoption of irrigation pump wells by small farmers.
3. A means through which "downs" can participate in the planning and execution of diffusion programs, including setting program priorities as to which innovations will be diffused, should be provided.
4. Special diffusion agencies should be established to work only with "downs," thus enabling change agents to meet the particular needs of the lower socioeconomic audience. If such an agency had existed among the Colombian coffee growers studied by Havens and Flinn (1974), it might have provided agricultural credit to the small farmers so that they could adopt the new coffee varieties.

Wider Gaps Are Not Inevitable

Field experiments by Shingi and Mody (1976) and by Röling and others (1976) suggest Generalization 11-7: *When special efforts are made by a diffusion agency, it is possible to narrow, or at least not to widen, socioeconomic gaps in a social system.*

The Shingi and Mody (1976) field experiment in India evaluated the ceiling effect strategy of providing messages that are redundant or of less interest and/or benefit to "ups" but appropriate to the lower socioeconomic subaudience. Two Indian communication scholars, Prakash M. Shingi and Bella Mody, content-analyzed agricultural television programs before they were broadcast in order to determine the twenty-one main items of information about wheat-growing and potato-raising innovations that they contained. The television programs were designed to provide useful information to smaller farmers in India, but to be redundant with much of the information already possessed by larger farmers.

Shingi and Mody (1976) found that larger-sized farmers with large properties watched only a few of the televised programs before they were "turned off" by viewing agricultural information that they already knew. Farmers with small properties eagerly watched the television series because the information it contained was new to them. All farmers had unlimited access to viewing the programs on a community television set that was provided to each village by the government of India.

Shingi and Mody measured the degree of agricultural knowledge before and after the television programs, in personal interviews. Gaps between "ups" and "downs" were narrowed by the television programs because of the ceiling effect: "By choosing program content that large farmers already understand, television producers can *close rather than widen* the communication effects gap" (emphasis in original). Shingi and Mody concluded that *"The communication effects gap is by no means inevitable.* It can be avoided if appropriate communication strategies are pursued in development efforts" (emphasis in original).

*The Digital Divide**

The *digital divide* is the gap that exists between individuals advantaged by the Internet and those individuals relatively disadvantaged by the Internet. A digital divide exists (1) within a nation such as the United States and (2) between European nations and the United States versus the developing nations of Latin America, Africa, and Asia. The numbers of Internet users per thousand population in various areas in 2001, when there were about 450 million Internet users worldwide, were:

North America	479 per 1,000
Western Europe	218 per 1,000
Latin America	21 per 1,000
Asia	17 per 1,000
Middle East/Africa	7 per 1,000
Worldwide	52 per 1,000

These wide gaps in Internet use result from a lack of economic resources, a lack of central-station electricity and telecommunications facilities, and government policies that discourage Internet use. For example, the government of China regulates all Internet traffic, which must pass through a government-controlled portal (this policy may be changing). At present, the considerable informational advantages of Internet access accrue only to certain individuals living in certain nations.

*This case illustration is adapted from Rogers (2002a).

In the United States, the digital divide separates individuals of higher and lower socioeconomic status, rural versus urban Americans, older versus younger individuals, and African Americans and Hispanics versus Euro-Americans. For example, a national survey by the National Technical Information Administration (NTIA) of 48,000 Americans in 2000 found that 34 percent of Hispanics and 33 percent of African Americans were using the Internet at home or at work, while the comparable figure for Euro-Americans was 56 percent. The characteristics of Internet users are similar to the characteristics of earlier adopters of most innovations. In order to use the Internet, an individual must have access to a computer (approximately half of U.S. households own a computer) and a telephone (owned by 94 percent of all Americans).

In 2002, about 71 percent of adult Americans were Internet users. Eventually, as the rate of diffusion of the Internet approaches saturation, the digital divide as we know it today will disappear. The inequality in access to Internet-provided information, however, may continue as the present access-divide is replaced by a learning-divide (in which certain individuals lack the skills of computer and/or Internet use), a content-divide (in which less educated individuals may not be able to comprehend the content of Web sites created by highly educated individuals), and other types of divides.

Several strategies can be utilized to bridge the digital divide. Public access to community computer centers such as cybercafés, which provide computer and Internet access, along with coffee and soft drinks, as a commercial service, or telecenters, which typically provide Internet access at no cost to the user. Such public access to the Internet is widespread in developing nations and in poor areas of the United States, where individuals and families cannot afford to buy computers and pay Internet access fees. Much could be done to bridge the digital divide by creating Web sites that are prepared especially for individuals with lower levels of formal education. For example, Web sites should be written at the eighth-grade level, as are newspapers in the United States, to reach the mass audience. However, as mentioned previously, a content analysis of health-related Web sites showed that they were written at a level requiring at least a high school education (Berland et al., 2001). The Internet allows individualized messages about an innovation to be sent to late adopters and laggards. To date, however, this potential for tailoring messages to the "downs" has been utilized only on a very limited scale.

Summary

Consequences are the changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation. Although obviously important, the consequences of innovations have received inadequate attention by change agents and by diffusion researchers. Consequences have not been studied adequately because (1) change agencies have overemphasized adoption per se, assuming that an innovation's consequences will be positive, (2) the usual survey research methods may be inappropriate for investigating consequences, and (3) consequences are often difficult to measure.

Consequences are classified as (1) desirable versus undesirable, (2) direct versus indirect, and (3) anticipated versus unanticipated. *Desirable consequences* are the functional effects of an innovation for an individual or for a social system. *Undesirable consequences* are the dysfunctional effects of an innovation for an individual or for a social system. Many innovations cause both positive and negative consequences, and it is thus erroneous to assume that the desirable impacts can be achieved without also experiencing undesirable effects. We conclude that the effects of an innovation usually cannot be managed so as to separate the desirable from the undesirable consequences (Generalization 11-1).

Direct consequences are the changes to an individual or a system that occur in immediate response to an innovation. *Indirect consequences* are the changes to an individual or a system that occur as a result of the direct consequences of an innovation. They are the consequences of the consequences of an innovation.

Anticipated consequences are changes due to an innovation that are recognized and intended by the members of a system. *Unanticipated consequences* are changes due to an innovation that are neither intended nor recognized by the members of a system.

The undesirable, indirect, and unanticipated consequences of an innovation usually go together, as do the desirable, direct, and anticipated consequences (Generalization 11-2). An illustration is provided by the introduction of the steel ax among Australian aborigines, which caused many undesirable, indirect, and unanticipated consequences, including breakdown of the family structure, the emergence of prostitution, and misuse of the innovation itself. The case of the steel ax illustrates three intrinsic elements of an innovation: (1) *form*, the directly observable physical appearance and substance of an innovation, (2) *function*, the contribution made by the innovation to the way of life of individuals or to the social system, and (3) *meaning*, the subjective and frequently subconscious perception of the innovation by members of the social system. Change agents more easily anticipate the form and function of an innovation for their clients than its meaning (Generalization 11-3).

Stable equilibrium occurs when almost no change is occurring in the structure or functioning of a social system. *Dynamic equilibrium* occurs when the rate of change in a social system is commensurate with the system's ability to cope with it. *Disequilibrium* occurs when the rate of change is too rapid to permit the system to adjust. Change agents generally wish to achieve a rate of change that leads to dynamic equilibrium, and to avoid disequilibrium.

One goal of diffusion programs is to raise the level of Good in a system. A second dimension of consequences is whether the *distribution* of Good among the members of a system becomes more or less equal. The consequences of the diffusion of innovations usually widen the socioeconomic gap between the earlier and later adopting categories in a system (Generalization 11-4). Further, the consequences of the diffusion of innovations usually widen the socioeconomic gap between the audience segments previously high and low in socioeconomic status (Generalization 11-5).

A system's social structure partly determines the equality versus the inequality of an innovation's consequences (Generalization 11-6). When a system's structure is already very unequal, the consequences of an innovation (especially if it is a relatively high-cost innovation) will lead to even greater inequality in the form of wider socioeconomic gaps.

What strategies could be followed in order to narrow gaps? The answer depends on three main reasons why socioeconomic gaps ordinarily widen as a consequence of diffusion: (1) "ups" have greater access to information that creates awareness of innovations; (2) they have greater access to innovation-evaluation information from peers; and (3) "ups" possess greater slack resources for adopting innovations than do "downs." When special efforts are made by a diffusion agency, it is possible to narrow, or at least not to widen, socioeconomic gaps in a social system (Generalization 11-7). In other words, widening gaps are not inevitable.

The *digital divide* is the gap that exists between individuals advantaged by the Internet and those individuals relatively disadvantaged by the Internet. This inequality exists both within the United States and between North America and Europe versus developing nations. Efforts to bridge the digital divide, such as providing public access to computers and the Internet in cybercafés and telecenters, are under way.