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The Media Revolution in America and in Western Europe

Volume II in the Paris–Stanford Series

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Chapter 6

The Impact of New Communication Technologies[1]

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INTRODUCTION

The computer is the heart of the new communication technologies that are now beginning to have important social impacts in the home, the office, the school, and the factory. Here an American and a European scholar who have pioneered in communication research on the new technologies combine to synthesize some lessons learned about the acceptance and use of these new media, their positive and negative consequences, and the basic changes in the nature of communication research that are demanded. In many countries, communication scholars are turning to study new communication technologies; a theme of the present chapter is that very major reorientations will be forced in the predominantly linear effects-oriented studies of mass communication researchers in the past. More attention must be given, for example, to convergence models of communication because of the interactivity of the new media. Thus, it is argued: "The Information Revolution may cause a Communication Research Revolution." ***E.M.R., F.B.***

We live in a society that is well into the early stages of experiencing an "Information Revolution" in which the *nature* of the individual household, the work organization, and society itself is undergoing a very major transformation (Forester, 1980; Warnecke and others, 1981).

1. Many countries (for example, Japan, the United States, Canada, and most of Western Europe) are becoming "information societies" (Nora and Minc, 1978; Schmoranz, 1980; Machlup and Kronwinkler, 1975; Picot, 1979), in which (a) more than half of the work force is engaged in occupations that mainly entail the processing of information (examples are a teacher, manager, secretary, computer programmer, or journalist), and (b) more than half of the GNP (gross national product) is from such in-

[1]The present chapter originated during 1980–1981, when Professor Picot was a Visiting Scholar at Stanford University, where he collaborated with Professor Rogers in research on the impacts of electronic messaging systems. This chapter was then developed further during Rogers's visit to the Federal Republic of Germany, where he consulted on Picot's research projects on the impacts of office automation. Certain of the ideas in this chapter are also reported in Rice and Rogers (1983).

formation-processing work. Information is about to replace energy as the basic resource on which an economy runs. Microelectronic innovations of information-processing and transmission are the powerful forces driving the development of the information society (Rogers and Larsen, 1984).

2. At the organizational level, the very nature of work life may be changing, due to the impact of such new communication technologies as video- and computer conferencing, electronic messaging, word processing, telecopying, and electronic filing and retrieval. These technologies are presently at a very early stage of diffusion and adoption, but their potential impact may be considerable (Rogers, 1983b).

3. At the household level, new communication technologies like interactive television systems (representing a unique combination of computers, satellites, and cable television), videotex, home computers, and videotape recorders are being introduced. These innovations too are at a very early stage of acceptance, and some (like interactive television systems) are only at the stage of relatively small-scale experimentation by national governments and by private companies. In fact, the reality of use of these new technologies as disclosed by surveys of users, provides a sobering contrast with well-publicized accounts of their future potential. For example:

- The PRESTEL system has been available for 5 or 6 years in England, but has only about 10,000 subscribers today, many fewer than originally expected.
- The QUBE system in Columbus, Ohio, U.S., is used interactively only rarely by participating households (Chen, 1981); a similar experience has been reported with interactive TV systems in several other nations.
- Home videotape recorders are only used an average of about 12 minutes per day, and that mostly to record TV broadcasts for delayed viewing (these are results from a recent survey in Sweden). In the United States, Levy (1980) reported an average of about half an hour of video recorder watching per day.

At the heart of the new communication technologies being applied to society, work organizations, and the home, is the computer. And what is new about these computer applications is their small size and low cost, an advantage made possible by putting increased amounts of computer memory and computer control, on a semiconductor chip. The Information Revolution, is fundamentally, a Microcomputer Revolution. Together with other technical innovations, microelectronics technology increases the capacity of both crucial components of communication technology (Picot and Anders, 1983a and 1983b): (a) the technical network, which allows

for the telecommunication of signals, and (b) adequate end-user equipment, which allows for comfortable handling of complex telecommunication processes. Chips, digital data transport, fiber optic cable, and other new technical means enhance the quality, quantity, and speed of information traffic in technical communication networks. Microcomputer innovations enrich the end-users' terminals by facilitating access and handling, as well as by integrating this equipment with other functions of information processing (storage, retrieval, computing, printing, etc.).

SOCIAL IMPACTS OF NEW COMMUNICATION TECHNOLOGIES

As we face the potential, yet unfulfilled, of the new communication technologies, one might expect that social scientists in general and those specializing in communication behavior in particular, would play an important role in conducting policy-relevant investigations. But this has not occurred to date. As an eminent Finnish scholar stated:

> The communication scholars could have been in the forefront of not only studies of new communication technologies but also in planning their applications. However, research has been both late and inadequate; many fine research opportunities have been lost forever. Research data have been replaced with personal opinions and normative value judgements. (Wiio, 1981)

But in very recent years, a small number of useful researches have been carried out that deal with certain aspects of the new communication technologies. There are an estimated 83 field experiments underway on videotex around the world, but many, especially in the U.S., are being conducted by private companies that will not allow scholars to gain access to their research results. Based on the authors' participation in several investigations, and our literature review of others, plus personal discussions with some of the researchers and practitioners involved, we wish to draw certain general lessons about the nature of the impacts of the new communication technologies. We will concentrate heavily, but not exclusively, on the new communication technologies being applied in the work organization.

Our discussion of impacts takes the form (a) of important research results or perspectives, and (b) of methodological problems and their partial and/or possible solution.

Channel Versus Content Studies

The general research question addressed by a very great deal of behavioral research on new communication technologies in the work organization is: "What are the effects of the new communication technol-

ogies?'' This question is similar to the main direction of mass communication research in the United States and (less so) in Europe for the past 40 years, but with some very important differences. One such contrast is that the contemporary research concern is with the impact of a new type of communication *channels*. Although computer-based communication technologies are much more than just another communication channel—very often they are, at the same time, a tool for information-composition, searching, filing, and retrieval—many studies deal only with the channel effect, rather than with a particular type of message content (Short, Williams, and Christie, 1976; Johansen, Vallee, and Spangler, 1979; Christie, 1981). For example, we now study the effect of electronic messaging systems in the office, while various mass media researchers have studied the effect of TV violence on children. Both are effects studies, but they are quite different in the details of their research design and in their degree of specificity.

But clearly there are parallels in the general research designs used in past media effects studies, and in contemporary researches on the impact of new office (and home) technologies. This similarity is entirely understandable, but we are concerned that a too-close following of the intellectual paradigm of the past will limit the policy payoff of present research. Nevertheless, we begin by listing some of the important effects now being investigated in studies of new office technologies, and then suggest some additional possibilities.

Channel Use in Organizations

How does the introduction of new communication technologies in a work organization change the existing patterns of organizational communication?

A general issue here, of great importance, is to determine the magnitude of the consequences of the new technologies. Do they indeed cause a ''revolution'' in communication behavior? The early evidence on this point seems to be negative. The impacts are incremental, rather than revolutionary. For example Picot, Klingenberg, and Kränzle (1982) conclude from studies of the impact of new office automation technology in German organizations that new electronic text media (such as computer mail, telefax, and computer conferencing) will mainly replace such older text media as mail and telex, which—in terms of number of contacts—play a minor role in organizational communication. These new media will replace oral channels only to the extent that oral communication is used for transmission of relatively simple information content. However, the proportion of that kind of oral channel use is not very high in organizations. The explanation for this finding is that much face-to-face communication is still considered necessary by organizational participants, mainly (a) for

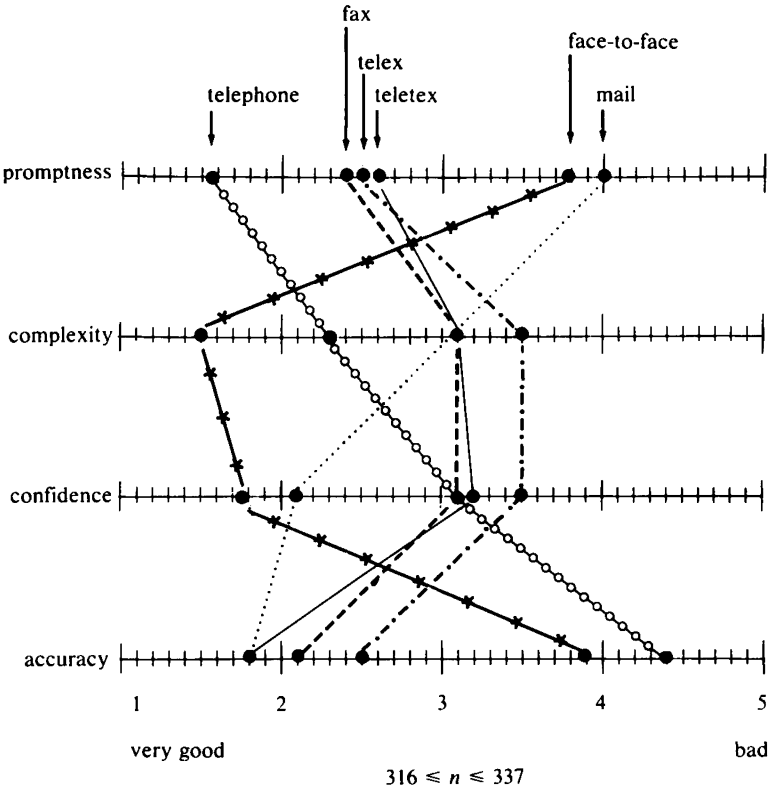


Figure 1. Task-Oriented Evaluation of Communication Channels in Organizations

its social relationship content, and (b) for the complex task-oriented, non-programmable information that it conveys.

Organizational hierarchies emerge because they are more economical for carrying out difficult information-exchanges associated with certain types of divisions of labor (Williamson, 1975 and 1980). This information-exchange demands a high symbolic and material communication capacity typically provided by oral (especially face-to-face) channels (Watzlawick, Beavin, and Jackson, 1967). The new media cannot serve as an equivalent substitute for the "social presence" that is crucial for the functioning of social relations and of unstructured information-exchange (Short, Williams, and Christie, 1976; Picot, Klingenberg, and Kränzle, 1982). Thus, new communication technology will facilitate various intraorganizational communication processes, but it will not wipe out the principal problems of information-exchange characteristic of organizations. On the other hand,

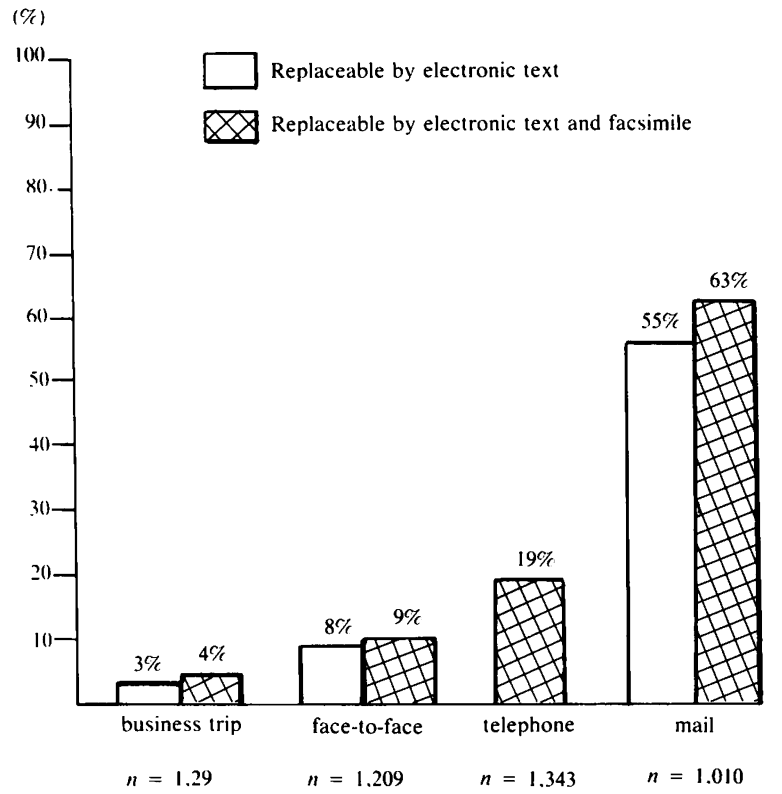


Figure 2. Amount of Potential Channel Substitution by the New Text-Oriented Technologies

the structure of external organizational communication, which to a greater part consists of standardized information-exchange, will be more greatly affected by the new text media.

The German research found four key problems to be overcome by organizational communication:

1. Managerial promptness,
2. Semantic complexity,
3. Interpersonal confidence, and
4. Administrative accuracy.

The suitability of six organizational communication channels for resolving these communication problems is shown in Figure 1. In terms of number of contacts and in terms of time consumed, the first three problems prevail

in organizational communication and the fourth is also of eminent importance for administrative functioning. This general assessment of the new communication technologies' suitability for organizational communication is reflected in Figure 2, which shows, on the basis of an empirical substitution analysis, the degree to which the new electronic text and facsimile media are perceived as capable of replacing business trips, face-to-face contact, telephone, and mail.

These conclusions are also generally supported by our findings from investigating the "Terminals for Managers" (TFM) electronic office messaging system at Stanford University (Rogers, Heath, and Moore, 1981). Highest use of TFM was by the accounting and finance officials of the university, who were mainly exchanging budgetary-type data; academic officials of the university used TFM much less, in part because more of their message content involved social relationships or complex task-oriented questions for which they preferred face-to-face (or telephone) channels.

The general issue here is what existing communication behavior the new communication technologies substitute for. Also important are such topics as expressed in the two research questions that follow.

Structural Changes and Organizational Communication

To what extent do the new office technologies support or subvert the organizational structure as it channels communication flows?

One of the anxieties expressed about the introduction of certain new technologies, such as electronic messaging, is that it will break down the constraining effect of the organization's structure on communicating behavior. Will a top executive be swamped with messages when all of the organization's employees are directly connected to the official by an electronic messaging system? Will the relative ease of sending "carbons" of messages lead to problems of information overload? Does removing the constraining effect of physical distance (and the effort required to communicate across it) between two individuals in an organization greatly increase the volume of messages that they exchange? Or will the new technologies, by enabling employees to work at home, increase physical barriers to face-to-face interaction among colleagues? To what extent will the role of "bosses" and secretaries be reversed by the new office technologies (as has been reported in some organizations, with the "boss" now doing his own typing/composing and the secretary moving into new office managing tasks)?

One of the general issues here is who communicates with whom, via what channels of communication, before and after the introduction of the new office technologies. This question is made to order for communication network analysis to answer (Rogers and Kincaid, 1981). But we

know of no such investigation that has been conducted to date. We ought to measure the impact of new communication technologies on the users' interpersonal networks, through a "pre-post" research design.

We stress the optional character of the new technologies: They offer a potential which can be used in either direction. New communication technology in organizations can provide individuals with more, better, and more relevant information, and thus enable them to become more autonomous decisionmakers. Thereby the organization's hierarchy can be flattened. On the other hand, these technologies can be used in a way that isolates people from each other and that tightens control by managers over office workers by demanding instantaneous feedback about current work progress. Thus, technology itself is neither good nor bad. Rather the way technology is used in a certain situation tells us much about an organization's climate, ideology, or problems.

As far as the geographical decentralization of work is concerned, we feel that the new technologies will allow homogeneous work groups and rather independent job-holders to locate their activities in remote places, perhaps far away from their mother organizations. Thereby organizational coordination shifts from a hierarchical pattern to a more decentralized mode involving a tendency towards office workers' compensation on the basis of measurable outputs. However, such teleworking will not represent a majority of office workers, as most office tasks are not programmable on a clear input/output-basis. Thus, most office jobs cannot be scattered, and have to remain concentrated in order to guarantee the unstructured interpersonal information-exchange which is necessary for most organizational problem-solving and control. A requisite for the successful build-up of social relationships and complex information-exchange, social presence cannot be satisfactorily replaced by telecommunications (Short, Williams, and Christie, 1976; Klingenberg and Kränzle, 1983; Brandt, 1983).

Office Productivity

How will the new technologies affect office productivity? Will the greatly-increased capital costs be offset by reduced labor costs gained through increased labor productivity? What problems (including management relationships with clerical unions) will accompany the reduction in the total office labor force that is likely to occur? To what degree will the quality of work life be improved through the reduction of repetitive, monotonous tasks like typing? Will employee stress of certain types be increased, such as by working on display terminals? Will the organization's capability of adaptation to change be improved?

A comprehensive economic evaluation of new communication technology is a most difficult task (1) because many of the assumed effects

are difficult to quantify, although they seem to be very important (for example, an improved information supply and increased flexibility), and (2) because the effects occur at different levels of observation (the individual, group, organization, and society). In order to overcome these difficulties, a multi-level framework has been developed which should guide evaluation discussions. Interestingly enough, that concept was independently and almost simultaneously proposed in Europe (Picot and others, 1979; Picot and Reichwald, 1979; Picot, 1979) and in the U.S. (Bair, 1979a and 1979b). It discerns costs and benefits at four levels of evaluation which have to be explored and taken into account before a proper decision can be made:

1. Isolated equipment efficiency;
2. Efficiency of a subsystem's throughput;
3. Efficiency of the organization; and
4. Social efficiency.

These concepts have served as a basis for empirical evaluation research (Picot and others, 1979; Bodem and others, 1983). Results show that the payoffs from new communication technology lie mainly in non-quantifiable performance, rather than in monetary cost calculations.

The difficulties in measuring the impacts of office automation on productivity may be one reason why the rate of adoption of the new office technologies seems to have slowed somewhat in very recent years. Organization leaders have to decide to adopt on faith, rather than hard evidence.

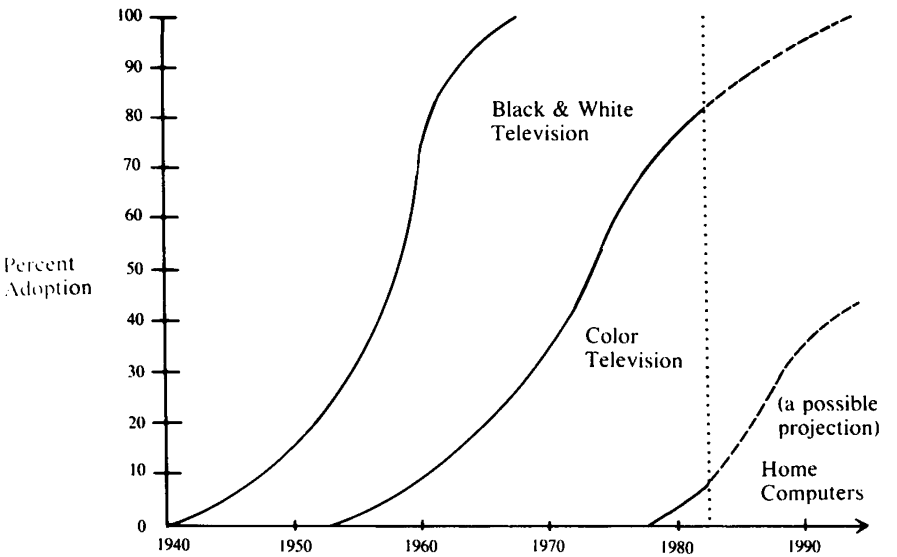
Equality

Do the new office technologies have greater effects (a) on certain individuals in an organization than on others, and (b) on certain organizations? Here we are looking at whether the technologies are information gap-widening or gap-narrowing. At issue is the degree of equality in the consequences of the new communication technologies.

One basic, and often implicit, assumption in this discussion is that technology-richness would trigger information-richness, i.e., that access to new information technology would provide a higher quality level of information. Although this assumption can be contested under certain circumstances, it seems acceptable in many others. The issue of equality is of central importance in the case of new communication technology in the household, where policymakers are concerned about whether this relatively expensive technology will widen the knowledge gap between the information-rich and the information-poor. Certain types of knowledge (that only certain individuals will possess) can be converted to political

power, in some cases. For example, a U.S. data-bank that can be accessed with a home computer and a telephone modem connection now provides daily voting records of national legislators, as well as the U.S. president's daily schedule. Such information might be useful to the politically-active citizen. Access to the German *Bildschirmtext* system grants a much higher level of market transparency in the banking, travel, or insurance industry than consumers can dispose of otherwise.

In the case of such past communication technologies as television, it seems that the new technology, in its process of diffusion, first widened knowledge gaps in society, but eventually closed them, when everyone adopted the innovation (Katzman, 1974). This first-widening/then-closing sequence occurs if the technology is widely adopted, and the temporary inequalities are less serious when the rate of diffusion is rapid (as with television in the U.S.). But what about an expensive communication technology like home computers that may never become a consumer item in all households (Figure 3)?



Note: At any particular point in time, a new communication technology has the effect of widening the knowledge gaps in society, because the first to adopt are the socioeconomic elites who are already the information-rich. But later, when everyone has adopted the technology, it again has an equalizing effect between the information-rich and the information-poor. But what about a technology like home computers that may not reach 100 per cent adoption?

Figure 3. Diffusion Curves for the Adoption of Three Household Communication Technologies

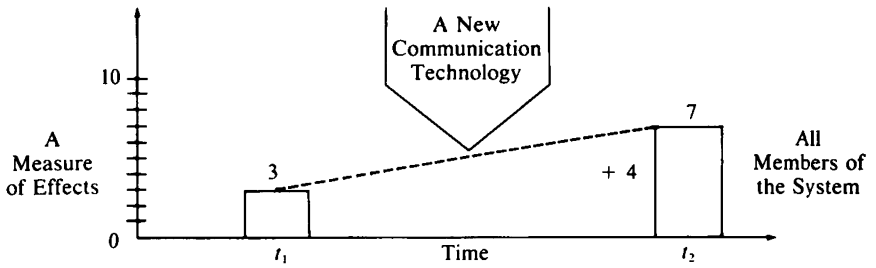
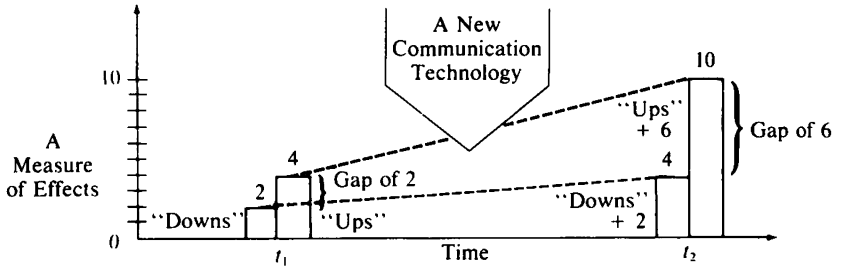


Figure 4a: The First Dimension of Communication Effects (for all members of the system) as an Average Increase of 4 Units, Measured as the Difference from t_1 to t_2



Note that the "Downs" are *absolutely* better off as a result of the new communication technology (+2), but they are *relatively* worse off (as the "Ups" gained +6). So the rich get richer (informationally) and the poor get less poor. (*Source:* Rogers, 1983a.)

Figure 4b. The Second Dimension of Communication Effects (which analyzes effects separately for "Downs" and "Ups") Indicates that the Effects Gap is Widened by the Introduction of a New Communication Technology

Is there a close parallel to the case of new office technologies? Figures 4a and 4b depict two dimensions of communication effects: (a) the first dimension, where we ask "What average or aggregate effect does a new communication technology have?" and (b) the second dimension, where the main research question is "Do certain individuals or systems experience a relatively greater effect of the new communication technology than do others?" Policy-makers are usually very interested in the equality dimension of new communication technology; they are concerned with the new technology's potential for creating a wider gap between the information-rich and the information-poor.

Such gap-widening often occurs (unless strategies are explicitly followed to prevent it) because:

1. The new communication technologies of home computers, teletext and videotex systems, videotape recorders, etc. in the home, and teleconferencing and electronic messaging in the office, are expensive. So only the socioeconomic elites can afford them. They adopt them first, and others can only follow slowly, if at all.
2. Because these new technologies are computer-based information tools, an individual must be a motivated information-searcher to use them (at least effectively). The information-rich are most likely to be the first adopters.
3. Those new communication technologies that support inter-individual communication require that potential communicators are equipped with compatible devices (electronic mail, picture phone, teletext, telecopy, computer conferencing, etc.) so that a relevant network can emerge. Such networks are much more rapidly created among the early adopting information-rich socioeconomic class than among other potential users. Thus, the information-rich get richer by networking. This argument can be applied to international, national, and organizational levels of investigation, as well as the individual.
4. The information-rich particularly want specialized information, which the new communication technologies are uniquely able to provide. Thus, they can increase their information advantage. An example of this point comes from an evaluation of *Bildschirmtext*, an interactive information system (videotex) now undergoing experimentation in Düsseldorf and Berlin. The several thousand accepters of this technology use the *Bildschirmtext* system to obtain specialized information about news, travel, banking, and to purchase catalog products.

ACCEPTANCE AND USE

A second major issue in research on new communication technologies is how they are accepted and used. In fact, this issue obviously precedes the issue of effects, in that effects only occur after acceptance. The acceptance issue has generally received less research attention than have the effects questions, at least to date, in the case of new office technologies.

Networks and the Critical Mass Problem

How does the networking nature of the new office technologies affect their acceptance and use? A general research paradigm of the diffusion of innovations (Rogers, 1983a) is directly applicable to studying acceptance

of new communication technologies, but of course with some very special twists. One particular aspect of many of the new office technologies is that they provide an improved means for connecting with other individuals (or organizations); thus these technologies essentially are "networking," not one-way "broadcasting" nor "stand-alone" technologies. This distinctive aspect affects the acceptance and use of the new interactive technologies. At one extreme consider the only individual in an organization who has an electronic messaging system; it is worthless to him as a means of communicating with his co-workers. As each additional individual gains access to this technology, its usefulness increases to each of the individuals already on the system. Another example: Consider the employee whose boss sends him a message via the new technology. Here the networking nature of the technology strongly encourages the individual to use the technology to respond.

More precisely the real diffusion take-off of a new communication technology heavily depends on a "critical mass" of individuals (or organizations) which must have adopted previously. Only if one can be sure that a majority of current addressees can be reached by a specific communication tool will one be willing to use it on a habitual basis. Thus the net benefit to an end-user of equipment for individual communication is influenced by the number of installations within his/her relevant group of reference. There is no exact formula available for calculation of the minimum level of the critical mass that is necessary for adoption to occur. However, a critical mass for a new communication technology must be higher, if:

- The relevant communication contacts to be carried out by the new technology are perceived as less important.
- The group of potential addressees who must be reached by the new technology is large and varied.
- The proportion of communication messages to be carried by the interactive technology is low compared to the total communication volume of a typical user.
- The new technology's use is not compatible with other information services that can serve as a substitute or a complement for that type of communication.
- The new interactive technology demands installation of a new physical network.

By thorough analysis and, if possible, influencing of these (above) determinants, the level of the critical mass can be roughly assessed and, perhaps, lowered. Reaching a critical mass, once it is assessed, can be accelerated by:

- Careful market segmentation and initial concentration on the relatively closed networks of potential user groups.
- A low price-strategy during market introduction.
- Decentralized installation of end-user equipment.

Such steps will facilitate purchases and terminal access; they will increase communication traffic and help create new experiences with the technology which in turn may trigger new adoptions. The history of the diffusion of the telephone illustrates these points.

During the first phases of diffusion, potential users and decision-makers might better adopt a wide, rather than a narrow, view of the adoption decision. Usually people interpret investment decisions as choices for or against adopting a stand-alone unit. The decision calculus asks, for instance, whether the cost per unit is lower when using the new machine compared to existing procedures.

If this decision rule is applied to interactive communication technology, the result may be unintended (Picot 1982). Figure 5 shows a network of information flows between four points (for example, departments in an organization) with the figures representing the average number of communication contacts per day suitable for electronic text communication. A cost analysis on the basis of investment costs and operating costs of the old and new equipment may show that production and mailing of 10 or more messages per day is necessary for an economically advantageous application of the new communication technology. Thus, according to traditional stand-alone decision-making, Departments A, C and D would purchase new equipment. However, A and C would not be able to secure these expected economic benefits, as part of their mail goes to B who decided not to adopt. Thus A and C can only achieve their return on investment in the new technology if B also adopts the new technology.

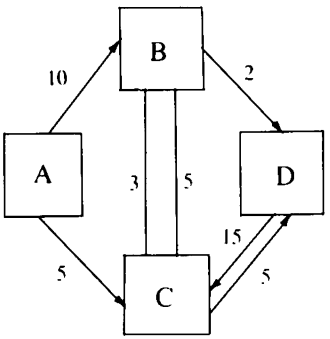


Figure 5. Information Flows in a Network (number of contacts per day suitable for electronic text communication)

Hence, B's adopting will create the critical mass for adoption by the others. This acceptance can be achieved through: (a) lowering the costs of the technology, (b) subsidies, or (c) shifting the responsibility of the adoption decision to a higher level such as an association of these organizations or the government.

The foregoing discussion suggests that *how* a new office technology is introduced may be at least as important as *what* the technology is.

Redesign and Implementation

How can the new office technologies be redesigned so as to become more acceptable and more useful?

This research question puts the behavioral scientist in the position of designer/redesigner of the communication technologies, along with the more familiar role (in the past) of evaluator of effects. In fact, the two roles seldom can be kept completely distinct in research on the new communication technologies (as we show later in this chapter).

Here a specific issue to be studied may be: What are the factors preventing acceptance/use of the new office technologies (such as computer fear, lack of typing ability, and concerns about the invasion of privacy)? The interface between the individual and the technology is crucial here, an issue that is far from completely understood in the case of the new office technologies.

Perhaps people have a basic desire to use the new technologies in their own unique ways, to be active shapers of the tools rather than just passive "acceptors." We feel this issue needs more attention than it has received to date; investigators often have overlooked the creative and individualized ways in which people use technological innovations (Rice and Rogers, 1980). Five individuals may adopt the same make and model of an office word-processor, but modify this tool to do five different tasks.

Redesign of technology also involves its organizational embedding. Implementation of new office communication technology may affect job characteristics, work relations, and organizational structure, often in a beneficial way. However, in order (a) to reduce fears and resistances from employees, (b) to mobilize motivation, redesign capabilities, and relevant knowledge about communication needs, and (c) in order to ensure later acceptance and cooperative use, a transparent, participatory planning and implementation strategy should be followed. Involvement of affected managers and office workers at an early stage in the discussion and implementation process is important for long-term success with office automation.

Naming The Technology

How important is the name of a new communication technology as a factor in its acceptance?

Market research on new products consistently shows that what an innovation is called has an influence on its acceptance. Obviously it is the potential users' perceptions of a new communication technology, including its name, that determines its rate of adoption. New communication technologies ought to be given names that are meaningful and understandable to the users. Instead, names are often given in a way that, while technically correct, may confuse potential users and turn them off. We ought to devote much more care than in the past to the name for a new communication technology.

"Bildschirmtext" is composed of three German words: *"Bild"* or picture, *"Schirm"* or screen, and *"Text."* An official in the Ministry of Posts and Telecommunication chose this name to stress that *Bildschirmtext* uses a TV set only as a screen, and not for broadcasting (as the frame-images are conveyed to the home by telephone line). This non-broadcasting aspect of *Bildschirmtext* is important to the Ministry for Posts and Telecommunication, which has responsibility for telephone services but not for TV broadcasting. This non-broadcasting nature of *Bildschirmtext* is also conveyed by its logo: a prominent symbol of a telephone, on a blue TV screen, with the name *"Bildschirmtext"* written underneath the telephone in computer text. Whether this name and symbol are appropriated for the system's users is not known, as the new service is still in the process of being introduced. One may doubt that the political distinction between a TV broadcasting and a telephone-channel technology is very important to the users, and in fact the system offers much more than just text on a screen.

The same emphasis on the telephone is found in the German Ministry of Posts and Telecommunication's most recent experiment with "BIGFON" (pronounced "big phone"), *Breitbandiges Integriertes Glasfaser-FernmeldeOrtsNetz*. This broadband fiber optical experiment is now getting underway in six German cities. The acronym does not reveal the real nature of this new network technology, at least as it is likely to be perceived by users.

The "Green Thumb" system was originally named "Extele" by U.S. government officials, indicating the technology's role in providing extension service information at a distance (to farmers). But a U.S. senator's secretary began calling the system "Green Thumb," a name that stuck (to the dismay of the technologists who designed the system). Kentucky farmers (the users), however, reacted favorably to the name "Green Thumb." So, by accident instead of design, this new technology was given a name that seemed to help its acceptance. At least the name is unforgettable.

The French teletext system, officially called "ANTIOPE" (for *"L'Acquisition Numerique et Televisualisation d'Images"*) after Antiope,

daughter of the king of Thebes in Greek mythology, is widely confused by the public with the French (and English) word "antelope."

The naming of new communication technologies is often done rather haphazardly, or, worse, by technologists without the benefit of formative evaluation to guide their choice of words that would be meaningful to the public. Understandably, such names then hinder acceptance of the new technologies by the public.

METHODOLOGICAL LESSONS

Figure 6 diagrams a somewhat typical research design for studying the impacts of a new communication technology. The main elements in the design are a sample of users of the new technology (perhaps at least 100 to 200) from whom data are gathered, often by means of personal interviews, both before (at t_1) and after (at t_2) the introduction of a new communication technology. So far, the design is the usual one for a field experiment, based on the kind of experimental design that behavioral scientists have taken from the classical physics of some years ago.

The distinctive aspect here is the possibility of obtaining "use-data" from the technology system itself, such as from computer records of an electronic messaging system or from an interactive television system (Rice and Rogers, 1983). The use-data indicate who uses the technology, how frequently, and for what purpose. Sometimes data are also gathered from

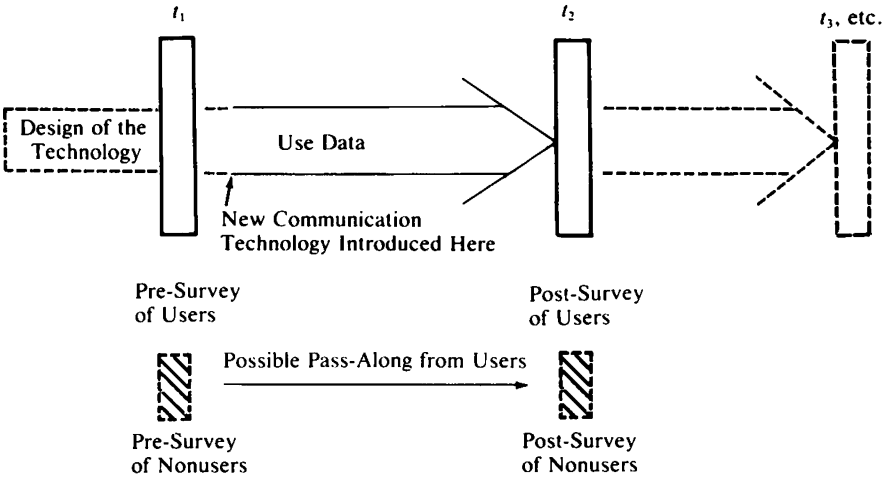


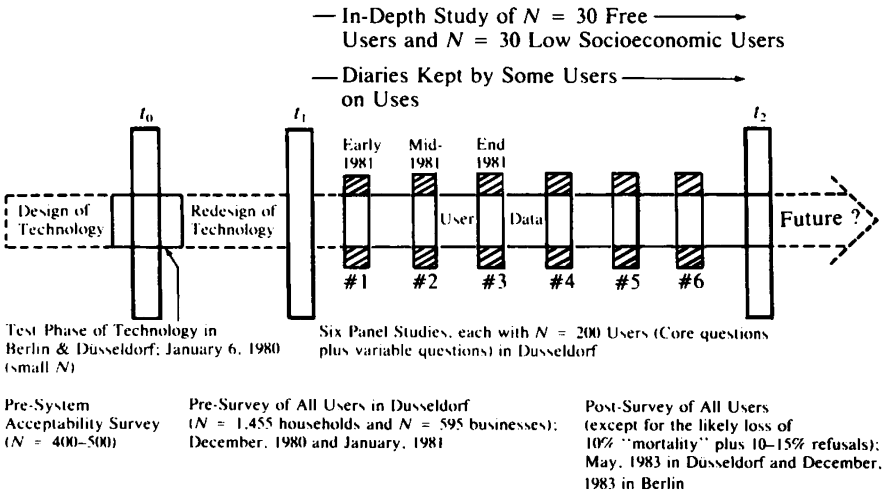
Figure 6. Diagram of a Usual Research Design for Studying the Impacts of a New Communication Technology.

a sample of non-users of the communication technology, who may have received pass-along information from users.

A number of methodological questions and problems accompany the usual experience with using this type of research design.

The evaluation researchers usually enter the research process too late to make their maximum contribution. Very seldom do the behavioral science researchers participate in designing the communication technology, where engineers and technologists usually dominate. Sometimes, there is no t_1 survey of future users (as in the 1981 Green Thumb Project by Stanford University). Then, the researchers must depend mainly on the users' perceived and remembered impacts of the communication technology (a rather unsatisfactory methodology for data-gathering).

But sometimes behavioral scientists are involved very early in the technology design process, as occurred in the *Bildschirmtext* Project in the Federal Republic of Germany (Figure 7). Here the evaluation researchers conducted an "acceptability" study of potential users of *Bildschirmtext*, and of the actual users in a short test phase of this interactive TV technology. The purpose of this formative evaluation research was to gain understandings of the future acceptance of *Bildschirmtext*, by



Note: Not shown here is a survey of the 800–900 private information-providers, who are mainly studied by the Kammerer Research Group (in Munich) at the Berlin location. The Düsseldorf users studies are mainly conducted by Infratest Media-Forschung (in Munich) under the direction of consultant Prof. Dr. Heiner Treinen of the Ruhr-University Bochum.

Figure 7. Diagram of the Evaluation Research Design for the *Bildschirmtext* System of the German Ministry of Posts and Telecommunications in Düsseldorf and Berlin

dealing with such questions as how many (and which) households would purchase the *Bildschirmtext* services, at what price, and how the technology should be designed/redesigned for user acceptance. A somewhat similar strategy was chosen for the planning, design, and implementation of the new office automation service in Germany (Picot and Reichwald, 1979).

Such acceptability studies of a new communication technology face many difficulties, stemming from the basic inadequacies of most available social science methods to predict future behavior. Nevertheless, acceptability studies represent one type of formative evaluation that at least involves behavioral scientists along with the technologists early in the process of designing the communication technology.

The computer-recorded use-data often cannot be matched with the pre/post survey data. There are many possible reasons for this problem, such as that each unit of the technology (such as a computer terminal) may be used by various individuals other than the individual that it is officially assigned to (such as the secretaries of the official users of the TFM system in the Stanford University study). There are also confidentiality problems of an ethical nature, which may prohibit analysis of the use-data because it cannot be matched with individual users. And there is the problem that the computer recording of use-data may be intrusive (and thus affect use of the system) if the users know that their use is being recorded.

Logistical and timing problems often interfere with execution of an ideal research design. Perhaps all of the intended users do not get their equipment at t_1 (Figure 6), or perhaps they are not trained to begin using the new technology at t_1. Sometimes the technology is changed/modified/improved from t_1 to t_2, perhaps due to feedback from an early evaluation research. Then exactly what technology system is being evaluated as to its impacts?

There is often no control group for comparison with the users, so it is impossible to remove the effects of other variables on use of the communication technology (Figure 7). The lack of a control group often occurs in studying a communication technology, such as when it is introduced in an entire organizational unit at the same time. It is difficult to do otherwise, given the network nature of interactive technologies (this is the critical mass). Perhaps another unit could be selected as a control group, if it matched fairly well. But even then, the random assignment of respondents to treatment and control groups is usually impossible. There are just so many problems involved in having a true control group in field

experimentation (Picot, 1975), that they are almost never utilized in evaluations of a new communication technology. As a consequence, such evaluations consistently overestimate a new technology's effects, because any extraneous effects that may exist are included as a disguised residual in the measured effect. This problem should not be forgotten when we analyze and report the research results of these studies.

Other means of control can be (and are) utilized in evaluating new communication technologies, such as multivariate statistical control. But such an evaluation design is weaker than an experiment because all of the variables to be controlled on must be measured; in an experimental design, all variables are controlled, whether measured or not.

Users of the new communication technology often are not representative of the population of future users, so the research results cannot be generalized. The issue of the generalizability of an experiment's results are illustrated by our respondents in the 1980–1981 TFM study, who were the top 110 administrators at Stanford University. Are they typical of the next 110 users of TFM at Stanford? Hardly. And how representative is Stanford University of other organizations that are expected to adopt TFM in the near future? Probably not very.

Another example of the generalizability problem while evaluating the impact of new communication technologies comes from the *Bildschirmtext* Project in Germany. The 1,455 household users of this interactive TV system in Düsseldorf were recruited through two campaigns aimed at recent purchasers of color TV sets (Figure 7). The 1,455 users probably tend to be socioeconomic elites, like the early adopters of most other innovations (the individuals in the left-hand tail of the S-shaped diffusion curves shown in Figure 3). One indication that the households volunteering to be participants in the *Bildschirmtext* Project were already information-rich is shown by the fact that about 25 per cent of these volunteers had home videotape recorders, compared to only 3 per cent of all German households at the time. The evaluation studies carried out in order to assess the impacts of office automation in Germany show similar biases; after intensive search, two large organizations were found for field experimental studies (they surely were among the pioneer adopters of any new office technology).

The general lesson that we are learning here is that individuals, families, and organizations that voluntarily participate in a communication technology experiment are very untypical of the population of potential users. Instead, the users in an experiment are usually typical of the early adopters of an innovation: information-rich and socioeconomically advantaged.

It is very difficult to avoid this threat to generalizability, even when

one tries. For example, in the Green Thumb Project in Kentucky, the 200 users of this free system (in 1981) were chosen by a local committee from the approximately 400–500 farmers who applied for a Green Thumb Box (in response to a mailed announcement from the local county extension agent to about 2,600 farmers in the two counties of study). The committee chose the 200 users so they were approximately representative of three categories of farm size (small, medium, and large-sized farmers). This selection procedure guaranteed a range of socioeconomic status among the 200 users, but it introduced another bias: The small-sized farmers who volunteered to participate tended to be untypical of all small farmers in the two counties in that they had a high degree of prior contact with their county extension agent (most small farmers do not have much extension contact). So the Green Thumb selection procedure guaranteed that small farmers were included in our study, but also tended to make these small farmer-users untypical of all small farmers. And a further problem: The Green Thumb system was free to the user in 1981 (thanks to the U.S. Department of Agriculture), but a fee was charged later for the Green Thumb service. Not many small farmers will use Green Thumb in the future. So again our small farmer-users in the 1981 study are a sample whose research results cannot be generalized to any future users.

The *Bildschirmtext* Project went to special pains to include lower socioeconomic status households in the Düsseldorf evaluation study. As Figure 7 shows, 30 users were recruited by offering free service (all other households paid a monthly fee of 5 *Deutschmarks*, or about $2.50 (U.S.), plus any frame charges; many of the 150,000 frames are available at no charge, but others may cost from .001 to .99 *Deutschmarks* per viewing), and another small sample of 30 users were identified from among the lowest socioeconomic households to apply for the *Bildschirmtext* system. Both of these small samples were investigated via unstructured personal interviews, group interviews, and by telephone, and (according to the evaluation research group) these research results from the extremely information-poor were useful in redesigning the *Bildschirmtext* system.

The research strategy suggested by the *Bildschirmtext* Project is to concentrate certain data-gathering activities on "extreme groups": households very low in socioeconomic status, for example, or the information-poor (and/or perhaps for contrast, a small sample of the information-rich, the socioeconomic elites, or the highest users). The strategy amounts to oversampling sub-audiences that are usually underrepresented by volunteer participants in the trial of a new communication technology. But with this oversampling strategy, the researcher does not have a random sample from a population of future users (and thus cannot utilize statistical inference as a basis for generalizability of the evaluation research results).

Quantitative research approaches, based on a notion of "variance research," seldom can provide a satisfactory understanding of the behavioral change process through which a new communication technology has effects. Almost all research designs for evaluating the acceptance and effects of new communication technologies (a) are highly quantitative, and (b) follow a variance research approach (Figure 6). Usually these researches (a) measure a large number of variables, (b) with data gathered from a large sample of users, at least several hundred and perhaps several thousand (as in the *Bildschirmtext* evaluation, where German politicians in the national parliament influenced the Ministry of Posts and Telecommunications to design an evaluation of the technology with several thousand users in two locations). The assumption here is that a large sample of users will provide more precise research results about acceptance and impacts (as well as helping the communication technology pilot project move rapidly toward becoming a national program).

Variance research is a type of data-gathering and analysis that consists of determining the co-variances among a set of variables but not their time-order (Mohr, 1982). A pre/post design (Figure 6) heads an investigation toward using (a) "difference" statistics (like the t-test between means or analysis of variance) in his/her data-analysis, or (b) "correlational" statistics (like zero-order correlation, multiple correlation and regression, or partial correlation techniques) in which the researcher seeks to determine the correlates of a dependent variable, which often is either acceptance or use of the new communication technology.

Variance research alone usually cannot tell us much about the time-order of our variables of study, other than rather crudely (through the t_1 to t_2 differences in a variable), and seldom can provide a very complete understanding of the over-time process nature of the behavior change effects that are caused by the new communication technology. In this situation, a process research approach may be more appropriate.

Process research is a type of data-gathering and analysis that seeks to determine the time-ordered sequence of a set of events. Data-gathering methods for process research are often more qualitative in nature (like participant observation, the case study, and unstructured interviewing). A special advantage of such qualitative methods is that they allow the investigator (a) to identify unexpected variables, and (b) to study the wider context of the user system and of the new communication technology. For example, the *Bildschirmtext* evaluation involves qualitative data-gathering (a) via user diaries, and (b) from an in-depth study of 30 low-income users.

Process research is not necessarily qualitative. For instance, the *Bildschirmtext* evaluation includes quantitative data-gathering from the

six-stage panel of 200 users, in which a set of core variables are measured every four months or so (Figure 7). This panel strategy allows tracing user behavior changes over a number of time periods (this approach is highly intrusive in that the repeated data-gathering undoubtedly conditions the responses that are gathered, although with the large sample of *Bildschirmtext* users that are available, this intrusion may not be too serious).

Variance and process research are not necessarily in competition; a research design can include both approaches, with each providing a unique type of data. Most research designs for evaluating the impacts of new communication technology consist solely (or at least mainly) of quantitative data-gathering for variance research. That is certainly a mistake, in our opinion.

Evaluation researchers who study a new communication technology are presumably separate from the managers of the new technology system, but in practice they are usually almost co-designers (or co-redesigners) of the new communication technology. Conventional wisdom about evaluation research holds that the evaluators should be independent and separate from the system or program that they are evaluating. Politicians and other policy-makers often require such separation, so as to minimize possible pro-technology biases of the evaluation. For instance, U.S. Department of Agriculture officials required that the Green Thumb system be evaluated by other than the University of Kentucky (who operated the 1980–1981 Green Thumb Project in two Kentucky counties). And German government officials and politicians required that the Ministry of Posts and Telecommunications contract with external research groups for evaluation of the *Bildschirmtext* system. The independence of the evaluation researchers from the technologists who design and operate the technology system is thought to raise the credibility with which the research results are perceived. In many cases, such independence and separation may indeed create a healthy tension between the evaluators and the technologists, and lead to more reliable research findings about the technology's effects.

But the reality of the situation is usually that the evaluators and technologists must collaborate closely if an evaluation is to be conducted in an effective manner, and if the research findings are to be utilized to improve the communication technology through its redesign. Often this redesign occurs during the time period (t_1 to t_2 in Figure 6) in which the communication technology is being evaluated; the evaluators suggest needed improvements to the technologists, which may then be implemented. This sequence of events was partly the case in the German office automation studies.

Further, it does not seem so certain that the independence of evaluators and technologists is ideal, even in principle. It may be crucial for

both technologists and behavioral scientists to be involved jointly in a new communication technology; each has an important type of expertise to contribute to the new communication technology project. Perhaps it is realistic and advantageous for the technologists and behavioral scientists to be organized as one team of equals, rather than always insisting on their separate independence.

CONCLUSIONS AND DISCUSSIONS

At this crucial time, communication research can play a useful role in determining the impacts of the new technologies, so that government and private policies can be more soundly based upon empirical evidence. In order to play this crucial role, the nature of communication research must be quite different from past studies of the effects of the mass media; many of the new technologies are interactive, hence linear models of the communication process, based on the single act of communication, are inappropriate. Perhaps convergence models of communication, which conceive of human communication as the exchange of information among participants, are more valuable in investigating the new interactive communication systems (Rogers and Kincaid, 1981). Finally, due to the computer element that is part of the interactive technologies, a variety of new types of data can be utilized in impact studies. Investigations of the new communication technologies will thus change the methods and theories of communication research.

Thus the Information Revolution may cause a Communication Research Revolution.

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