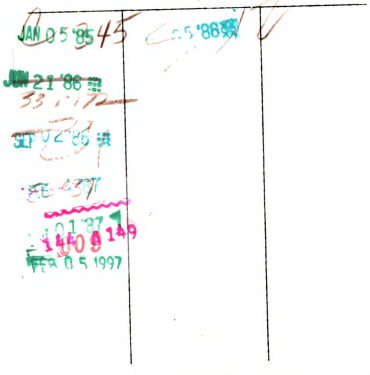

THE ADOPTION AND APPLICATION OF COMPUTER-BASED TELECOMMUNICATION TECHNOLOGIES BY HOME CONSUMERS

By

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ABSTRACT

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Recent developments in technology, policy and industry standardization have stimulated growth in the number of possible applications of information processing technology. The ponderous question of whether better information processing and telecommunication machines can be built is no longer relevant. The issue to be recognized now is, given the multitude of design alternatives, which options should the designers of home information systems select? On what basis should these decisions be made? How can human satisfaction and competence with these sophisticated systems be maximized?

These are the issues contemplated in the present research effort. The underlying theory is that given a set of communication needs, people will try to satisfy these needs by seeking out and adopting various technologies. Those technologies which embody the most salient attributes should be adopted more successfully.

To study the process by which home consumers adopt telecommunication products and services and apply these to serving communication needs, a two study approach was employed. The first study was designed to collect information from home consumers regarding their self-perceived communication needs and the degree to which various

attributes of telecommunication technologies were salient to them. The second study used a Delphi technique administered to a sample of telecommunication experts knowledgeable about technology. In this study, a set of estimates was derived indicating the extent to which various telecommunication technologies were appropriate for providing a number of computer-based services.

Major findings of the consumer study are that human communication needs are significantly related to the salience of technology attributes. The importance of technology attributes to consumers predicts their economic value. Present telephone usage patterns also predicted the economic value of technology attributes. Several intangible attributes such as attitudes towards computerization and social interaction can explain some variation in the perceived salience of technology attributes. Finally, the Delphi Study revealed that two-way cable and telephone technologies were the most appropriate media for the provision of computer-based services. Limitations of the research and future directions are discussed.

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My wife, Sara, is perhaps my most influential colleague. She has a very special way of listening to my babblings and somehow reflecting these back to me as polished ideas. Her keen insight and ability to articulate things has always helped me to develop my ideas into something worthwhile. I have always felt that there is something magical about her. Finally, I acknowledge the love and support that my two sets of parents have shown. Sara's parents and my parents contributed much to our creature comforts and human nourishment. Their concern and generousity allowed me to pursue more lofty goals. I hope that I can live up to their expectations and the example they set.

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CHAPTER I

INTRODUCTION

Driven by imaginative applications of computer-based and telecommunication technologies, the dawning of the information age is rapidly becoming a personal reality for home consumers. Sophisticated information and communication technologies have been readily accessible to business and institutional users for years. The size, expense and level of sophistication required for successful operation has tended to inhibit the growth of these products and services into the consumer market. Small, affordable and user-friendly consumer oriented versions of these technologies now loom on the horizon. In fact, the rapid proliferation of small home computers and video games seems indicative of the interest and energy home consumers find for these technologies.

Much research has been directed toward an exploration of the relationships which exist or will probably exist between the human users of these systems and the affinities of the technologies themselves. There is an interest in designing computer-based systems so that they are efficient from a human viewpoint rather than emphasizing machine efficiency. This research has considered such problems as how the systems should be designed; who will use them; what are their skills; what are their needs; who will spend money to gain access to these systems? The success of these systems depend on the quality of the human-machine interface. While humans can adapt themselves to situations, efficiency, productivity and satisfaction are enhanced when

systems are instead adapted to human users. It was in this spirit that the present research was conducted.

Organization of report

Two separate studies were conducted in this research project. The first study surveyed a random sample of East Lansing residents. The second study used a Delphi technique to survey a purposive sample of respondents knowledgeable about telecommunication technologies.

This chapter introduces the research problem and the significance of this research effort. To establish this conceptual framework, a review of the relevant research literature is presented.

Chapter II considers the rationale and underlying objectives for the two studies. The study of East Lansing home consumers had the major objective of testing several hypothetical relationships regarding their communication needs, attitudes toward innovation attributes and the adoption and application of innovations. The purpose of the Delphi study was to estimate the extent to which a number of telecommunication technologies are appropriate for the provision of various telecommunication services and features to home consumers. The research questions addressed in this study are also discussed in this chapter.

Chapter III focuses on the methods used in the home consumer study. Chapter IV relates the data analytic procedures used and the statistical testing of the hypotheses for this study.

Chapter V is concerned with the methods of the Delphi study. Chapter VI presents and interprets the descriptive findings of this study.

Finally, Chapter VII summarizes the research findings and draws tentative conclusions based on these empirical findings. Directions for new research in this area are proposed.

Problem Statement

An interesting occurrence is the breakdown in the familiar boundaries among telecommunication marketplaces. Services no longer need to be associated with particular administrative or technological entities in telecommunication. In fact, similar services can be provided by technologically distinct telecommunication entities. Telephone companies are seeking to provide competition to cable television companies for the provision of broadband services. Paging services are offered by both broadcasters and common carriers. High speed data communications are available by satellite or several terrestrial alternatives. Videotex services can be provided via telephone, television, cable television, or broadcast radio. Although similar videotex services can be provided by different media, there are some differences. The type of service provided over these facilities will vary according to the technical affinities of the medium and other system variables. Thus, the telephone may permit two-way communication; FM radio may be cheaper and television may be faster but be limited in the size of its database.

The trend towards a redefinition of the telecommunication marketplace in terms of emerging innovations seems clear. These "innovations" are sometimes entirely new technologies, such as direct broadcast satellites or cellular radio and sometimes new applications of existing technologies such as imaginative uses of FM radio subchannels. To a large extent, many of these new developments are

being driven by advancements in telecommunication applications of computers.

A number of computer-based telecommunication technologies are in various stages of reaching the home consumer market. Some technologies such as two-way videotex are likely to be first targeted toward the business market before being rolled-out in the consumer market. Some testing has been going on around the nation to gauge preliminary interest in this type of interactive service. Likewise, one-way teletext systems have been introduced on a trial basis in several areas. Other technologies such as home computers, cable television, and various forms of pay television have already made a substantial impact on the consumer market.

The "impact" of technology on the consumer market can be approached in several ways. One way is to consider the impact on consumption patterns. In some cases, market segments will be attracted away from their current consumption patterns and enticed into bringing old habits to new media. In other cases, entirely new appetites for services may be whetted, leading to the instigation of new markets. Consumption effects in the former case are known as "functional displacement." In this case, the new media do a superior job of meeting needs at an equal or smaller cost to the consumer. In the latter case, a form of "functional placement" occurs. In this case, no consumption pattern exists prior to the introduction of the technology. After the technology is introduced, new needs are "discovered" which only the new technology can serve. An example might be the introduction of real time polling capability with interactive cable television which provides the home viewer with the means to respond to multiple choice questions.

In a complex environment of technological change, it will be difficult to predict which innovations will appeal to consumers and thus survive in the marketplace. Functional displacement effects are much easier to predict than functional placement effects. This is true because of the relative difficulty of trying to predict the emergence of "new" needs. In some instances, the agents of technological change seek to create new needs by first creating technologies and then trying to create markets for these technologies. This phenomenon is known as a "technology push" situation. Put another way, this is when there is a technological solution in search of a human problem.

On the other hand, new technologies may also do a far better job of serving basic human needs which are presently underserved or in fact unserved. In the situation where the problem precedes the solution, this is best described as a "demand pull." Whether a technology is to be accused of serving a demand pull or creating a technology push is somewhat subjective. For some consumer segments a particular technology may be inappropriate, while for other segments it may be highly appropriate. This differentiation task is a basic problem when considering the introduction of an innovation. In a sense, it is a classic marketing problem: does the product come before the market or vice-versa?

One of the concerns with telecommunication innovations is the extent to which these technologies correspond to the actual needs of the end users. According to the "marketing concept" the needs of a target population would be carefully studied by the entity producing the innovation. The product or service would then be designed and

deployed in the market in a manner consistent with the full realization of a recognized need. This approach is consistent with the demand-pull model of marketing. In the alternative model, technology-push, the needs of the consumer are inadequately considered in the design and marketing of the innovation and may therefore fail to adequately serve these needs.

The essential task is to relate measures of human needs to the innovations. Beyond the conceptualization and design stages of telecommunication innovations, there is the problem of trying to predict who will adopt the various telecommunication technologies. In some cases, experience with existing technologies or analogous markets may be useful. It would be useful if the results from studies of telecommunication innovations could be generalized to consider other types of telecommunication innovations. But research findings based on the study of an innovation which has been considered as an indivisible entity may not generalize very well beyond the specific innovation studied.

One solution to the problem suggested here is that telecommunication innovations can be considered as divisible units which can be analyzed on the basis of their attributes. The intensity of perceived communication needs can be measured and related to expressed preferences for attributes of telecommunication technologies. If there is a strong relationship between the two measurement spaces of needs and attributes, one might conclude that a demand-pull model would be most accurate. When a demand-pull exists, the successful diffusion of the innovation might be more confidently predicted. In this case, those consumer segments with the greatest needs would be

predicted to adopt those technologies which embody the desired attributes to the greatest extent. Furthermore, it would be expected that these technologies would be applied to serve these same needs.

Once a set of needs measures has been related to a set of measures regarding preferred attributes, another relationship can be specified. Initially, the attributes will have been presented in an abstract context divorced from any connection with real world products or administrative entities. Thus, in the next stage, the relationship between the attributes preferred by the consumers and the possibilities for innovations must be considered. If no available technology contains the appropriate set or amount of the desirable attributes, this would be evidence that underserved or unserved human communication needs existed. A telecommunication innovation could then be developed and positioned to serve these needs.

There seem to be two deficiencies in most of the research considering the adoption and diffusion of innovations. First, there has been an undue emphasis on the characteristics of the innovator. Much useful knowledge can be gained by also considering dimensions of the innovations themselves. Another deficiency is the limited nature of most innovation studies. Of the substantial research thus completed, most of these studies have considered the innovation as an indivisible concept. This severely limits the generalizability of the research because findings tend to be "all or none" in terms of relevance to other innovations.

Review of the literature

The adoption and diffusion of innovations is a well studied topic.[1] Adoption studies investigate the process the individual engages when

making the decision to adopt or not adopt an innovation. Diffusion studies seek to explain the rate of adoption within a social system. Innovations are products, services or concepts which are perceived as "new" by the potential adopter.

Attributes of Innovations

"Innovations" or "innovative technologies" are constructs which have been operationalized in different ways. One author proposed that innovations must have one or more of these four properties: (1) newness from existing products; (2) newness in time; (3) newness in terms of sales penetration level; (4) consumer newness to the product.[2] In its most general sense, an innovation can be an idea, practice or object perceived as new to an individual. This newness need not be objective. In other words, something which has been around for a long time can still be new to the individual in terms of knowledge, attitude or decision to adopt an innovation.[3]

An innovation is usually considered to be "successful" if it is purchased or used by potential adopters. A practical outcome of innovation research is the opportunity to scientifically predict which innovations will ultimately fail, long before they reach the stage at which they are introduced to the marketplace. This is a significant problem as thousands of new products are introduced to the marketplace each year, many of which end up as failures.[4]

Recently, substantial research efforts have been made to identify key predictors of product successes and failures.[5] On the basis of this research, it can be concluded that understanding user needs, external and internal commmunications, product advantages and marketing efforts are all related to product success.[6] One study determined that three key dimensions could discriminate between successes and failures:

(1) product (superiority and user advantages); (2) marketing (knowledge and proficiency of activities); (3) technical/production (synergy and proficiency of activities).[7]

Thio suggested that the ability to predict adoption of an innovation is enhanced if the characteristics of both the potential adopter and the target innovation are studied.[8] He considered two constructions of compatibility between the adopter and innovation. Symbolic compatibility refers to the intangible attributes of an innovation which are subjectively perceived in an idiosynchratic manner. In contrast to symbolic compatibility, functional compatibility refers to innovation attributes which can be determined in a fairly objective manner. In this sense, these attributes are more tangible. Thio cautions that, in this approach, there is an equal importance between (1) the actor's symbolic interpretation (subjective perception) and (2) the observer's definition of functional requirement (objective assessment).

An interesting perspective on the study of innovations in telecommunication is that the adoption process usually requires the adoption of an intangible innovation (e.g. the way one communicates) in addition to a tangible innovation (e.g. the actual product or service). Since the process of communication is central to our functioning, the interaction of telecommunication innovations with the way we communicate is a compelling research consideration. The adoption of a tangible innovation usually involves a behavior such as purchasing or making use of a product or service. The adoption of an intangible innovation on the other hand, requires a symbolic decision. One might accept the cost and convenience of electronic home shopping

but reject the implied loss of social interaction due to the inherent nature of the technology. This would then lead to a rejection of the home shopping system, even though its tangible attributes perfectly suited the individual's cost and convenience needs.

It is this linking of intangible with tangible innovations that seems to distinguish the study of telecommunication innovations from other diffusion research traditions. It is important to consider not only the functional aspects of telecommunications innovations, but also the symbolic aspects. The functional attributes of innovations are relatively fixed (e.g. objective) characteristics. The symbolic characteristics of innovations are variable subject to individual perceptions.

Robertson describes innovations in terms of effects upon consumption.[9] A continuous innovation has the least disruptive influence on consumption patterns because the innovation is actually an existing product which has been altered in some fairly minor way. A dynamically continuous innovation more often involves the creation of a new product which has a greater effect on consumption patterns. Finally, a discontinuous innovation has the most disruptive influence on consumption patterns by creating previously unknown products. This classification scheme can be fairly arbitrary. For example, is the push-button telephone a continuous or a discontinuous product? In some cases, such as computers or satellites, the classification may be more clear (e.g. discontinuous innovations). The point here is that the adoption of any innovation leads to a change of some sort, whether it be in consumption patterns or in terms of the way one communicates.

Calantone and Cooper have used a cluster analysis procedure to devise an empirically based categorization scheme of new product types.[10] In contrast to Robertson's fairly arbitrary taxonomy of innovations, the cluster routine was able to generate nine product types. Since this analysis was data based, the outcome of nearly 200 new product offerings was plotted. Thus, each product type had not only its unique description but also an estimate of its likelihood of success. These product types included such innovations as "the innovative mousetrap that really wasn't better," and "the better mousetrap with no marketing." In their analysis and categorization, Calantone and Cooper examined primarily variables related to the product, marketing and production of the product.

A major premise of this paper is that changes in the way we communicate, due to the adoption of innovation, may have a great impact on our lives. To reiterate what was said earlier, it is this property of telecommunication innovations which contributes to the growing sense of importance to designing telecommunication systems which are sensitive to the needs and desires of human participants. Research on the adoption and diffusion of telecommunication innovations can offer a better understanding of how to design or select telecommunication systems which are functionally and symbolically compatible with the needs of the adopters.

Sirbu concluded that in the telecommunication marketplace, successful firms will develop innovative new products which are sensitive to human factors of communication needs and capabilities. In addition, these successful firms will need to have fast response capabilities to marketplace forces. This limits the usefulness of highly engineered, capital intensive but inflexible systems.[11]

Compaine has made the point that successful firms will need to envision their customers as information consumers and not book buyers or television viewers.[12] His argument is that the communication need resides in the unique utility of the content and not the conduit through which the information arrives. Compaine argues that new telecommunication technologies are doing little to change the actual content of information, but are making major changes in how easily information can be accessed and processed. Consumers are likely to make major investments in purchasing telecommunication products or services, only to the extent that they gain access to (or can process differently) information in a manner superior to their present capabilities.

In this light, Frank envisions an interactive database in the home as an example of a defined technology in search of a viable application.[13] Frank indicates that the real challenge is to create services that do not duplicate consumer information that the homeowner can get elsewhere, in other forms, at lower costs. Frank finds that even though fuel costs have risen, consumer response has been to plan better and combine trips to save money. The basic desire for mobility has not been eliminated. Finally, Frank perceives that the videotex industry is confident in its ability to develop unique applications that cannot be duplicated easily in other formats.

Chaffee and Petrick have suggested several basic parameters salient to a consideration of new technologies.[14] They hypothesized that the new technologies will be most socially significant to the degree that they extend our communicatory abilities in terms of (1) storage capacity; (2) access; (3) speed of transmission; (4) amount of information stored or transmitted and (5) reducing information

distortion. They argue that since interpersonal communication uses essentially the two senses of sight and sound, technical media innovations which permit the use of other senses of sight and sound, technical media innovations which permit the use of other senses will have only limited social impact. Media which develop the visual illusion of three dimensions (e.g. films of early 1950's) or pursue innovations such as "smell-o-vision" or "feel-o-vision" probably will not make it in the marketplace. They point out that cost is not necessarily a barrier for new technologies, so long as they serve a valid need. Broadcast television receivers were the most expensive consumer oriented technology but also the quickest to diffuse.

The attributes suggested by Chaffee and Petrick to describe innovations are fairly technical (e.g. functional). Rogers suggests that it is the attributes of a new product, not as seen by experts, but as symbolically perceived by the potential adopters that really matters.[15] In this spirit, he has summarized past thinking and research findings to develop a standard classification scheme for describing the perceived attributes of innovations in universal terms. These attributes, while not empirically independent, are conceptually distinguishable: (1) relative advantage; (2) compatibility; (3) complexity; (4) trialability and (5) observability.

Relative advantage is the degree to which an innovation is perceived as being better than the idea (product or service) it supercedes, or which it competes. Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, present way of doing things and needs of the receivers. Complexity is the degree to which the innovation is perceived as

relatively difficult to understand and use. Trialability is the degree to which an innovation may be experimented with one a limited basis. Finally, observability is the degree to which the results of an innovation are visible to others. Theoretically, innovations which are high in all attributes but complexity are most readily adopted. Ostlund found that innovative behavior (e.g. willingness to adopt a product if available) was positively correlated with relative advantage, compatibility, trialability, and observability, but negatively with complexity and perceived risk.[16] Similar findings are suggested by Rice and Rogers.[17]

Much of the research summarized by Rogers deals with innovations unrelated to telecommunication. However, some research has been done on telecommunication innovations. Graham for example, suggested that broadcast television diffused more quickly among members of lower social class levels because it was more consistent with the lower-class value system and way of life.[18]

Dozier and Ledingham used the scheme developed by Rogers and Shoemaker to investigate how people in a cable television market perceive the attributes of interactive cable services.[19] Typical applications of interactive cable television include in-home shopping and banking. A small sample was selected for a focus group interview. Respondents were asked to describe how they currently do things like "keep up with the news, shop, and bank." It was determined who in the household usually handled these tasks. Respondents then had various applications of interactive cable services described to them. These services potentially could do the same type of information tasks (e.g. news, shopping, banking) they were already involved with. Their responses to these descriptions were recorded and classified.

Respondents indicated that interactive cable did have a relative advantage in terms of being able to avoid traffic and waiting lines to conduct informational activities such as banking. But a relative disadvantage perceived by some of the respondents was a loss of social interaction. Whether interactive cable is perceived as offering relative advantages to current ways of doing things depends on several things. Interactive cable is more efficient than existing alternatives for some uses. If time-saving is an important consideration, interactive cable is more likely to be perceived as advantageous.

The respondents largely perceived interactive cable as a form of "computerization," which had a negative connotation. The theme which emerged was that people did not trust computers and were concerned with "further computer encroachment on individual self-determination and privacy." Attitudes towards computerization seemed to relate to the consequences of possible errors in computer operations, and loss of a human dimension in conducting transactions such as shopping and banking. Other respondents felt that interactive services would be compatible with their needs and values because of their desire to conduct affairs conveniently. In terms of compatability, a trade-off apparently existed between the negative connotations of "computerization" and the positive connotations of "convenience."

Rice and Rogers made similar findings with respect to computer conferencing systems.[20] They discovered that words such as "technology," "automation," "machine," or "computer" tended to increase the resistance of potential adopters to the symbolic idea behind the communication innovation. They suggested that adoption could be increased if the convenience of the system was stressed by presenting it as a tool.

For the types of service expected to be made available by the cable systems serving the areas in which the respondents lived, the installation and a cost of the service is not a major consideration. Installation consists of providing a converter and the service would cost about $6.00 per month. Nonetheless, respondents tended to perceive the service as fairly complex. They felt that it would require a major modification of their television sets and that it would be extremely expensive to install. Interestingly, several respondents perceived a "generation gap" feeling that they would need to rely on their children to teach them how to use interactive cable services. Children were thus expected to be "early and heavy users." Dozier and Ledingham concluded that, "the dynamics of learning within the household may well prove important in shifting the perception of the innovation from one of complexity to one of simplicity. Seeing the information utility as 'child's play' may well help accelerate the level of system use."[21] Experience was also seen to help to resolve inaccurate estimates of the level of complexity involved with operating the system.

The final two dimensions considered by Dozier and Ledingham were the trialability and observability of the interactive cable service innovation. They concluded that, "because installation of the converter is required to convert a household to two-way cable, and because learning of new skills is required to use the information utility, organized efforts to motivate early adopters to 'show off' the information utility to neighbors may speed the adoption process." There is a fair amount of empirical support in the diffusion literature to support this notion. Trialability essentially refers to the level and type of risk one is willing to take. The degree of risk perceived relative to

the innovation is negatively correlated with innovative behavior.[22] On the one hand there is the risk of not adopting an innovation which has the potential of being very useful and satisfying. On the other hand, there is the risk of adopting an innovation which does not meet expectations in some way. For example, the interaction between the functional and symbolic aspects of the innovation may not appeal to a certain type of person who may seek increased convenience but have a strong need for socializing. Observability seems to appeal to one's sense of vanity. If one does make the commitment to adopt the interactive cable service, there is a tendency to want to "show-off" the results of this decision by inviting friends and neighbors to see the service in action. The appeal of being the "first one on the block" to have interactive cable service is made more attractive if it is possible to show off the service.

Innovation Functions

In terms of the functional aspects of telecommunication innovations, Dozier and Ledingham noted that two distinct types of functions were perceived by respondents. Surveillance functions were described, in which the major activity was information gathering, such that information was displayed and observed but no modification of a database occurs. Transaction functions involve not only the display but also the modification of a database, as when bills are paid electronically. Surveillance functions were relatively more attractive than transaction functions to the respondents. The transaction functions seemed to suffer from perceptions of being more complex and less compatible than surveillance functions. The point here, is that there seem to be two different types of functional telecommunication innovations which should be considered on their own merits in future research.

Sirbu argues that to be successful, an innovation must provide (1) enhanced effectiveness or (2) reduced cost.[23] He also posits that it is not just price driven substitution but latent demand expansion that will tend to determine the characteristics of new telecommunication markets. In other words, it will be the new ability to serve the unserved or underserved existing and future communication needs that will play the larger role in the adoption process, while substitution demand based solely on price will be a less important formative force. Because of this, Sirbu suggests that the functional capabilities of each technology be well established and marketed on the basis of these merits.

The importance of considering attributes of the innovation is farily well established. These attributes have both symbolic (perceptual) and functional (objective) dimensions. The measurement of the functional attributes can be a fairly straight forward process, as suggested by Sirbu. Investigating the perceptual dimensions is an entirely different problem as noted by Rogers and Shoemaker and others. The five perceptual dimensions suggested by Rogers and Shoemaker are a useful beginning. Two problems are (1) how to measure the symbolic nature of the attributes; and (2) who or what to measure.

Perception of Innovations

Much of the innovation literature deals with the individual as the unit of analysis. It is also fruitful to consider households, neighborhoods or other aggregate units of a social system. Hauser and Koppelman have considered the trade-offs involved in different types of measurement and analysis schemes in dealing with the representation or mapping of perceptual space.[24] The three major techniques are (1) factor analysis; (2) similarity scaling; and (3) discriminant analysis. Hauser and Urban also attempted to deal more specifically with the importance of various

attributes in terms of utility functions.[25] Neslin has attempted with some success to represent relationships existing between product features (functional) and consumer perceptions of these features.[26]

Donnelly and Etzel studied variations in the degree of product newness and adoption.[27] Their argument was that past research tended to consider genuinely new (e.g. "discontinuous innovation" in Robertson's terminology) as equivalent to superficially differentiated products (e.g. "continuous" or "dynamically continuous" innovations in Robertson's scheme). They also argued that past research tended to be restricted to the consideration of single innovations rather than considering innovations across (or within) product categories, which potentially limits generalizability. Their study investigated the actual purchase of several convenience products of varying degrees of newness to determine whether early adopters of discontinuous innovations were different for the early adopters of continuous or dynamically continuous innovations.

Donnelly and Etzel had expert judges rate grocery store products in terms of four objective dimensions. For a product to be considered genuinely new, it must be considered new on all four dimensions, otherwise it was considered to be artifically new. One interesting approach used was to consider cognitive styles in terms of how subjects make judgements regarding differences. Pettigrew found that individuals characteristically allow for a certain range of differentiation or "category width" when assessing differences.[28] For example, "in selecting maximum values of various optical and auditory phenomena, subjects consistently had either broad, medium or narrow ranges of judgement."[29] Thus, someone who is a "broad categorizer" would tend

to judge extreme values in a category (e.g. greater distance from central tendency of a distribution) more often than would someone else who would be described as a "narrow categorizer."

The distinction to be made between "broad" and "narrow" categorizers is that if one's cognitive style is to think in terms of broad categories, one tends to assimilate stimuli (differences) in products, essentially overlooking them, recognizing only fairly major changes. Narrow categorizers, on the other hand, tend to emphasize any differences. This might mean that continuous or dynamically continuous innovations might appear as "different" and, therefore, "new" to narrow categorizers, but only relatively discontinuous innovations might appear as different and new to broad categorizers.

Donnelly and Etzel predicted that individuals with broad category ranges will purchase genuinely new products more frequently than individuals with narrow ranges. They also predicted that individuals with narrower ranges tend to purchase artifically new products more often than those with broader category ranges. They also felt that those in the middle ground would not be more apt to move in either direction in terms of consumption. Although their last hypothesis was actually a test of the null hypothesis, all of their hypotheses were statistically significant. To measure each individual's characteristic category width, a scale developed by Pettigrew was used in this study. Donnelly and Etzel concluded that attributes of the innovation may be as important as behavioral and demographics factors in identifying early adopters. They also found that products could successfully be differentiated in terms of relative newness.

Adoption Process

Much work has been done which contemplates the adoption process as a process of sequential stages. Mason found that only two stages are necessary and sufficient for adoption to occur, (1) awareness of the innovation and (2) adoption.[30] He used a Guttman technique of scalogram analysis. His findings indicated that the more complicated sequence of stages in the adoption process which was being proposed by rural sociologists had little merit. He found that adoption processes were not consistent but varied according to the practice studied and the individual farmer, thus no generalizations could be made beyond the two stage model.

Several other models have been developed which postulate a series of stages in the adoption process. These stages correspond to a sequence of psychological and behavioral processes which are assumed to be antecedants of innovative behavior. There is a fair amount of variation in the number and nature of these stages as identified by different researchers.

The traditional view of the innovation decision process recognized by rural sociologists was composed of five states: (1) awareness; (2) interest; (3) evaluation; (4) trial; and (5) adoption. Rogers modified this mode somewhat to describe a five stage process: (1) knowledge; (2) persuasion; (3) decision; (4) implementation; and (5) confirmation.[31]

The modified model proposed by Rogers resolves some of the deficiencies identified in the traditional rural sociology model. The three major deficiencies were that the five stage model implies that (1) adoption always occurs at some point; (2) the stages occur in order and no stage is skipped; and (3) that once adoption occurs it continues and the innovation is not rejected at a later time.

Robertson suggests that the exact form of the adoption process will vary according to several situational and individual variables.[32] The importance of the decision, in terms of consequences of an apparently incorrect decision is a consideration. The extent of meaningful product differentiation and the way the potential adopter categorizes these differences (e.g. narrow vs. broad categories) will have an influence. The extent of the product's conspicuousness (observability) and the consumer's desire for social approval will be related to the decision. Finally, the extent to which the consumer is financially or psychologically able to take risks as well as their decision-making ability will play a part in the adoption process.

Rice and Rogers find that, "it seems generally apparent that innovations are more successfully adopted when a known or expected demand pulls rather than when the awareness of a new technology pushes the innovation into the organization."[33] This conclusion that innovations which are matched to intrinsic needs will be more successfully adopted than those which fail to address real needs in a significant way is intuitively appealing. Tauber has found some support for this idea in a nonscientific study using a convenience sample of housewives in product concept-testing research.[34] It seems plausible that adopters who have a relatively high "innate innovativeness" may be more susceptible to a technology push because they are drawn to new ideas as a matter of their basic personality. However, the functional performance of the innovation which they have symbolically accepted may not support a final decision to adopt, due to various situational constraints.

One might hypothesize that telecommunication products and services will be most successful if they are useful for serving real needs. The

individual's appetite for social interactions may be superceded by a telecommunication system which offers great convenience at a similar or reduced cost. The telecommunication option may not be selected one hundred percent of the time, but to the extent real needs are met, this option may be more viable. Ideally, the "marketing concept" infers the process of carefully studying consumer needs and desires. Unfortunately, the variable typically studied by market researchers may actually be purchase interest in a product rather than the needs this product can serve.[35]

The individual's information habits should be studied from the "bottom-up" rather than from the "top-down."[36] In other words, these habits and preferences should be studied from the perspective of the consumer and not the industry supplier. To gain some qualitative insights into the way potential adopters may respond to various telecommunication innovations, Carey reviewed the way people generally approach and use information in their lives by considering the use of telephones and newspapers over time.

Carey arrived at several conclusions which may offer some guidance in the planning of telecommunication services. Carey noted in particular, that the development of newspapers and telephone seemed to parallel the way videotex services seem to be emerging, in terms of pricing and human factor barriers. Carey warns that this may signal a slow growth for videotex. Gauging from consumer response to telephone usage and billing, it is probable that people will take advantage of reduced pricing at off-peak hours. Carey indicates that people may prefer flat rate billing to per access charges.

Consumers typically may not have much experience in searching through large, complex databases which will be available electronically in the near term. The success of some innovations, such as videotex, may depend on the indexing structure of the software and the extent to which adopters are willing to or can learn how to access specific pieces of information or successfully conduct transactions. Carey finds that consumers have typically been exposed to systems using a simple two step indexing process. In newspapers for example, the first level is a main index to sections followed by a section index to stories. Users of the Prestel videotex service required from six to fourteen indexing steps to reach desired information.[37] An important question to be answered is whether potential adopters will have the patience or the skill to make detailed searches through large databases.

Ostlund observed that the emphasis in many studies to date had been forecasting the rate of adoption rather than the prediction of who would or would not adopt and why.[38] From a human factors perspective, it is more interesting to consider the adoption process. Ostlund pointed out that even adoption studies were lacking in their over-emphasis of personal characteristics of adopters. He suggested that attention be paid to perceptual variables relating to the perceived innovation attributes. Ostlund concluded that on the basis of his two studies of several consumer products, the perceptions of innovations by potential adopters are more important predictors of adoption than personal characteristics. Hauser, working specifically with telecommunication innovations, developed a methodology to study how potential adopters perceive innovations relative to existing technologies and to estimate the relative importance of various attributes of innovations.[39]

Inherent to the "human factors" approach to the development and diffusion of telecommunication technologies is a consideration of the attributes of the innovation. Considering innovations, not as distinct entities, but as collections of characteristics or attributes is not particularly unusual in the innovation literature. However, there has been little done to treat this formally. In the field of economics, Lancaster devised a new approach to consumer theory whereby it was assumed that utility was derived from the attributes of goods and not directly from the goods themselves.[40] Lancaster argues that conventional economic theory treated goods as single entities and not as collections of characteristics. Lancaster presented the notion that utility or preference orderings are assumed to rank collections of characteristics. In this case, goods are ranked only indirectly, as a function of their attributes.

Lancaster described the essence of his new approach to consumer theory by making three points. First, the good itself does not give rise to utility. Second, each good generally possesses more than one characteristic, and many characteristics will be shared by more than one good. Finally, goods in combination may possess characteristics distinct from those pertaining to the goods separately (e.g. synergism). Lancaster's primary contribution was not so much the basic idea of conceiving goods in terms of their attributes, but his advancement of the underlying theory.

Hauser estimated the demand and impact of telecommunication innovations by positioning these products in perceptual space on the basis of their attributes. In a similar fashion, Quandt and Baumol tried to estimate demand for different modes of transportation by studying the

relative importance of different attributes of transportation modes.[41] Quandt and Baumol acknowledged Lancaster's work but indicated that their ideas were developed without knowledge of Lancaster's thesis.

In essence, Quandt and Baumol hypothesized that it might be useful to define a transportation mode in terms of the types of service it provides to the traveler and not in terms of the administrative entity that controls its operations or the sort of physical equipment employed. Modes of transportation could thus be abstractly characterized in terms of several variables salient to transportation, such as: (1) speed; (2) frequency of service; (3) comfort; and (4) cost. By making differential specifications in terms of these four attributes, Quandt and Baumol were able to assess the relative attractiveness of abstract modes of transportation, which may or may not presently exist.

The utility of the model developed by Quandt and Baumol is that the attractiveness of modes of transportation not presently existing can be assessed. Furthermore, the impact of these non-existing transportation modes on existing modes can be estimated, should these new modes become available.

Quandt and Baumol subjected their hypotheses to a limited test and found encouraging results. The advantages of their model were found to be: (1) the ability to predict for every existing mode of transportation, the effect of introducing a new mode; (2) permitting the hypothetical introduction of a new transportation mode simply by specifying its attributes to a sample of potential adopters; and (3) making the forecast of total travel demand a function of the range of travel alternatives. They did note that originally their model assumed "modal neutrality" meaning that there would be no inherent liking or disliking

of particular modes of transportation. In consideration of such factors as "fear of flying" subsequent refinements of the model included binary terms to represent the presence or absence of non-neutral modes.

Both Lancaster and Quandt and Baumol have developed formal mathematical models to specify the role of innovation attributes in the adoption process. By analogy, their work is clearly applicable to estimating adoption and diffusion of telecommunication innovations. The attributes specified for telecommunication innovations could include the universe of characteristics to be associated not only with existing products, but also potential products with attributes presently unavailable to consumers. In this case, latent or unmet demand can be identified.

Collins discussed two types of demand which are influencial in forecasting the use of telecommunication services. The sources of demand are (1) diversion from existing means of telecommunication, e.g. substitution demand; and (2) generation of new traffic, e.g. latent demand.[42] Three dimensions can be useful in forecasting the demand for innovative telecommunication services. First, a detailed analysis of present information activities should be undertaken. Next, the suitability of candidate media should be assessed by evaluating their attributes. Finally, the cost effectiveness of each alternative should be weighed.

A number of studies have investigated the relationship between adopter characteristics and the rate at which innovations are adopted.[43] Three basic categories of variables have been considered: (1) demographics and socio-economic status; (2) personality variables; and (3) communication behavior. Boone for example, found that adopters of

cable television service were significantly different from non-adopters on a number of socioeconomic and personality variables.[44] Innovators are usually found to be more educated, more venturesome, have favorable attitudes towards credit, are less dogmatic, are better able to deal with abstractions and are more cosmopolitan. In fact, Rogers and Shoemaker have arrived at a set of thirty-two empirically based generalizations about the characteristics associated with adopter categories (e.g. time of adoption).[45]

Williams and Krugman used Robertson's criteria to establish that public radio was in effect a new product and, therefore, an innovation. They reasoned that since typical descriptors of innovators matched the characteristics of the audience for public radio, then a measure of innovativeness should predict public radio listening.[46] In fact, this was not the case and innovativeness was not a predictor of public radio listening. Other demographic and attitudinal variables were predictors, however.

Work which has been done to measure an inherent personality variable of "innovativeness"[47] or to locate individuals on a continuum of "adaptiveness" to "innovativeness,"[48] has met with some success. A problem with measuring innovativeness is that this variable seems to be a function of the attributes of the innovation studied and not a completely independent personality variable. Williams and Krugman concluded in their study of public radio listening, that their operationalization of innovativeness may have lacked construct validity. The innovativeness scale they used was developed in product acceptability studies, and they indicated that the link between product purchase decisions and public radio listening is tenuous.

Summary

In the thousands of innovation studies that have been conducted, scores of variables have been measured and analyzed. Most often the goal of this research has been the successful prediction of innovation adoption. While this is a useful end in itself, there are other possibilities. For example, the diagnostic value of innovation research has not been exploited sufficiently. Merely predicting the rate of adoption (diffusion) or which consumer segments are most likely to adopt an innovation may not be sufficient. In order to maximize the probability of producing an innovation which will be successful, the attributes of the innovations should be deliberately related to the needs of the potential end users. Ideally this would occur in the design stage of the innovation, but may also occur in a later marketing stage. To accomplish this, the kinds of communication needs individuals have and their affective orientation toward the symbolic and functional attributes of innovations should be studied.

Telecommunication products and services are likely to be most successful if they are useful for serving existing human communication needs which may be presently underserved or unserved by existing technologies. Two kinds of needs are considered here, those which the user is aware of to some degree, and those needs which the consumer is presently unaware of. If a new technology can serve a set of needs more efficiently than an existing technology, then the older technology will tend to be functionally displaced.[49] To the extent that the new technology stimulates the development of "new" needs (e.g. those which the consumer was previously unaware of), the new technology may be more uniquely attractive. It is a difficult research problem to consider

measuring needs which the consumer is unaware of. It is useful, however to consider the range of underserved needs. If consumers are not satisfied with what existing telecommunication technologies have to offer them, this knowledge is useful in predicitng who will adopt which technology and why (e.g. to serve which needs).

If newer technologies are expected to displace older technologies, these new technologies should be compatible with the needs served by the displaced technology.[50] If the newer technologies have tangible attributes which are functionally superior to the displaced technologies (e.g. cheaper, faster), but have intangible attributes (e.g. as subjectively perceived by the individual) which are less efficient in serving the needs felt by the potential adopter, these technologies may not survive for long in the marketplace. These human factor considerations should be made at all stages of the product life-cycle, from conceptualization to full-scale commercial deployment.[51] Interestingly, there is actually some concern that such attention to human factors and the marketing concept may actually retard the development of potentially desirable innovations.[52] However, this trade-off may well be worth it in the long run.

CHAPTER I

Reference Notes

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CHAPTER II

RESEARCH APPROACH

Conceptual Overview

This research is an exploratory study of home consumers and the adoption and application of computer based telecommunication technologies. In this research, telecommunication innovations are expected to be perceived by potential adopters as additions to an already existing range of options. In some cases, the adopter may use an innovation to functionally displace a more familiar way of doing things, because the newer way may be more efficient along one or more dimensions. In other cases, the adopter may acquire new habits or develop new needs when considering the potential applications of an innovation. In any case, options in the telecommunication environment, innovative or otherwise, are selected to the extent that they are able to meet the expectations of individuals. In this study, the potential adopter is seen to respond to an awareness of needs by seeking out stimuli from the environment which are expected to satiate these needs. In the present context, the needs considered are human communication needs and the stimuli are the attributes of various telecommunication options.

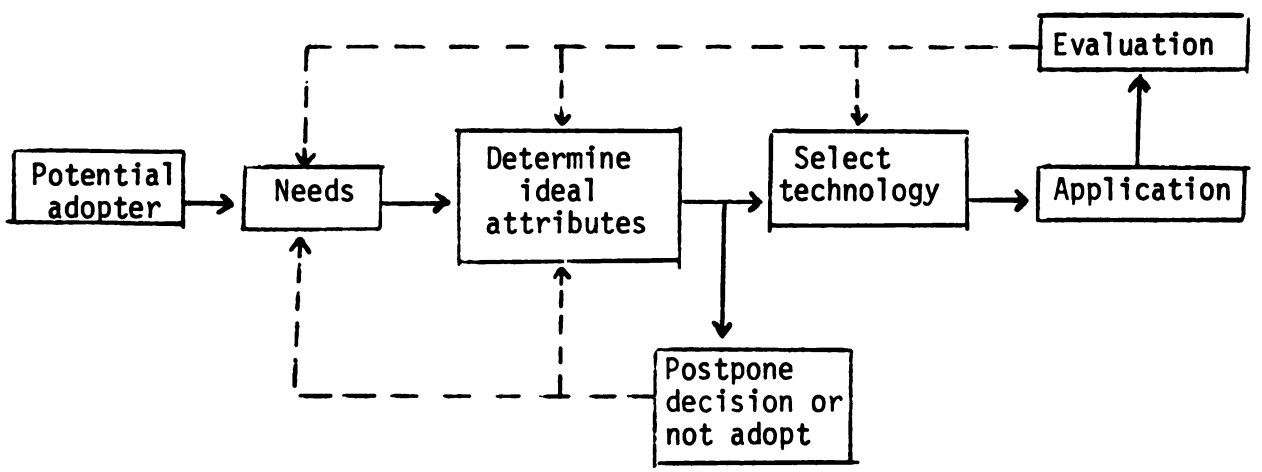
The conceptual model in Figure 1 illustrates a construction of the adoption process. In this model, the individual develops or becomes cognizant of one or more human communication needs. These needs generate

a corresponding drive to consider environmental alternatives for satiating the needs. The manner in which these alternatives are approached is derived from the cognitive style of the individual, notably in the fashion by which expectations are structured. Ideally, this model suggests that given a set of needs, the individual is able to generate a sort of mental shopping list of essential attributes which can provide satisfaction.

The model depicted in Figure 1 draws upon expectancy value theory, which is well supported in the field of social psychology.[1] An application of this theory has worked well to predict media exposure.[2] A relationship was found between gratifications sought and gratifications obtained from mass media and exposure to media. In a refinement of mass media uses and gratifications theory, significant empirical support was obtained which differentiated gratifications sought from gratifications obtained.[3] This work tends to support the generalization that individuals do seek out specific gratifications or attributes to satisfy needs, and that these attributes may or may not yield obtained gratifications.[4]

FIGURE 1

CONCEPTUAL MODEL OF THE ADOPTION PROCESS



In terms of expectancy value theory, the adoption or non-adoption of computer based telecommunication technologies can be seen to be a function of (1) expectancy and (2) evaluation. Expectancy refers to the perceived probability that an attitude object possesses a particular attribute. Evaluation, positive or negative, occurs after selection and application.[5]

In an application of expectancy value theory to mass media research to predict program dependency and media exposure, researchers have assumed that media consumers perceive media content in terms of divisible attributes and not indivisibly. This approach is maintained in the current study where potential adopters are thought to evaluate telecommunication alternatives not entirely as indivisible products with labels such as "cable television" or "home computers" but in also terms of their attributes or services. This is consistent with similar work done by Lancaster[6] and Quandt and Baumol[7] who have found some empirical support for this approach.

In the model (Figure 1), once the potential adopter develops a set of desirable attributes (e.g. mental shopping list), the individual seeks to match this ideal set with currently available collections of attributes (e.g. existing products and services). The range of alternatives considered acceptable by the potential adopter is affected by psychological and demographic variables such as knowledge, experience, willingness to take risks, financial status, innovativeness and social contacts.

The next step, according to the model, is the selection of a technological product or service which comes closest in attribute space to embodying the most salient attributes. If a selection occurs, a trial application follows. Adoption is not said to occur until after an evaluation, at which point the potential adopter decides whether or not

to continue using an innovation, assuming it was an innovation that was selected and not an older alternative. In either case, if the needs are satiated, this information is added to the individual's experiential repertoire. Otherwise, the process may be reengaged. The needs may be redefined in light of experience with what is available, the notion of what the ideal attributes are may change or the actual selection of a technology may change. A similar process is engaged if no initial technology selection was made.

The model implies iterative possibilities. The first path through is a "a priori" in the sense that it assumes that an individual develops a set of ideal attributes before actually determining whether these attribures will satisfy the needs. Successive paths through the model are "post hoc" and based on the experience of applying various attributes to serving needs. This transactional model can describe the orientation of a potential adopter to technological additions to the telecommunication environment over a period of time.

Of course, it is not very likely that the average person always engages an explicit and conscious decisionmaking process. Selections of technologies may be based on previously formed habits or other constraints. To this extent, the model may be limited. The model does work to deal with these possibilities to some extent by incorporating the possibility of a reduced attribute space being examined in the "ideal attribute" stage which would then lead to a reduced "technologies space."

Assuming there is some awareness of a telecommunication innovation, at least two general properties of these innovations may encourage an individual to remove mental cobwebs and become the relatively thoughtful,

information-seeking rational consumer considered in the model. First, the innovation is by definition, new to the potential adopter and therefore remarkable, if only in passing interest. The individual's curiosity may be sufficiently aroused to consider the innovation in greater detail. Another factor is consideration of cost. The cost of computer-based telecommunication innovations can be significant, relative to the household budget. Since a fairly sizeable investment can be made, the potential adopter may be more intent on arriving at a rational decision. This tendency is probably more pronounced as the adoption decision appears more irrevocable.

Some attributes of the innovations may initially tempt the potential adopter's imagination and interest leading to a desire to learn more about the innovation. The individual may first learn of an attribute or service only in the context of an innovation. Once aware of this attribute, the individual may go on to develop an appetite or perceived need for this attribute. In a sense, a new need will thus have been created. This form of functional placement is not in conflict with the model, but an extension.

It is likely that people will become aware of innovation attributes at some time or other, before they have a sense of a clearly articulated need. This is one of the problems of trying to predict new needs. There is likely to be an interaction between the recognition of salient needs and the awareness of salient attributes. In other words, the potential adopter may not always be able to express a need for something he or she does not know to exist in the external world.

However, people may have needs which they can recognize as being presently unserved or underserved. For example, most people would

probably like a service that would deliver feature movies to a high definition component color television system in their home on demand, for $1.00 per month. No one offers this service (not surprisingly!), so the "need" is redefined and perhaps a subscription to Home Box Office becomes an acceptable alternative. On the other hand, the drive to satiate this communication need may be channeled into something entirely different or perhaps lapse into a latent state.

This model can have several potential applications. First, given some knowledge of an individual's needs and their perceptions of various symbolic and functional attributes, a prediction can be made about which innovations, if any, are likely to be adopted. Second, some assessment of the impact of the adoption can be estimated. In other words, after adoption, how is the innovation applied? This question can be answered by examining which needs are apparently served. One might operationalize "impact" as the relative extent to which various needs are served.

Furthermore, diagnostic insights may be obtained from the use of the model. For example, if a certain set of needs are highly related to salient attributes, one would expect that individual to seek out the innovation which comes closest in attribute space to embodying the preferred set of salient attributes. If no existing innovation can meet this demand, this signals the need for the development of yet another innovation. This type of product positioning may also be useful in testing out product concepts long before full scale committments are made. This sensitivity to human factors may make or break a telecommunication firm in this increasingly competitive marketplace.[8]

Rationale for conducting two studies

As a partial test of the specified model (Figure 1), two studies were conducted. Three measurement spaces were operationalized: (1) salient human communication needs; (2) salient attributes; and (3) appropriate telecommunication technologies (See Table I). Statistical relationships were assessed between these measurement spaces. In one study, the relationship between needs and attributes was considered. In the other study, the relationship between these attributes and various telecommunication technologies was explored. An underlying point in the research here, is that by studying human communication needs and the salience of attributes, one can predict which technologies, innovative or otherwise, potential adopters will tend to adopt.

The idea of envisioning new products in the abstract as collections of attributes, actually different levels of different attributes, is fairly common in the marketing research literature. This approach to evaluating new product ideas has been used to assess consumer preference for various levels of different attributes for products that do not yet exist. Marketing studies have been successful in asking consumers to make a series of ranking judgements regarding a number of attributes for non-existent products. For example, in considering which attributes a new type of table radio should have, respondents made judgements regarding characteristics such as: alarm type (none, regular, snooze); case-type (pastic, wood); bands received (AM, AM/FM, AM/FM/SW, AM/FM/SW/CB) and cost.[9] Generally, this type of marketing research, known as "conjoint analysis," has been popular to test product concepts before the selection of final designs.[10]

TABLE I. VARIABLES USED TO OPERATIONALIZE NEEDS, ATTRIBUTES AND TECHNOLOGIES MEASUREMENT SPACES

Needs[a]	Attributes[b]	Technologies[c]
Current events	Fire and burglar alarm	One-way cable television
Useful information	Interactive video games	Two-way cable television
Government information	Utility meter reading	Broadcast television
Less time on errands	Energy management	Broadcast radio
Relax and reduce tension	Home voting	Telephone
Understand U.S. and world	Interactive instruction	Direct broadcast satellite
Be entertained	Electronic library	Multipoint distribution service
Kill time	Electronic mail	Low power television
Improve myself	Balance inquiry	Terminal equipment
Less time bookkeeping	Electronic funds transfer	
Talk with friends and relatives	General database	
Current information	Pay-per-view films	
Household finances organized	Medical alert	
TV match personal schedule	Electronic spreadsheet	
Reduce transportation costs		

[a]Items 5a-5o from the instrument used in the Consumer Study (Appendix A).

[b]Items 8a-8n from the instrument used in the Consumer Study (Appendix A).

[c]Items from part II of the instrument used in the Delphi Study (Appendices B and C).

If one were to assume that in fact consumers are relatively indifferent to actual products and are concerned only with the presence of various functional attributes, then so long as these attributes are available, one might expect what Quandt and Baumol refer to as "modal neutrality" exists among consumers.[11] In this case, consumers are expected to choose among technological alternatives for satisfying communication needs on the basis of their attributes or characteristics and not on the basis of what they are called. In Quandt and Baumol's example, air travel may be the best alternative in terms of the salient attributes. However, this alternative may not be selected because of a fear of flying. Similarly, in telecommunication, home shopping may be the best choice given tangible or functional criteria, but not be selected because of symbolic or intangible criteria. Thus, these variables must be accounted for and "modal neutrality" may not accurately describe consumer orientation to the various technologies.

To test a model linking (1) needs and attributes; and (2) attributes and technologies, respondents must be familiar with the three measurement spaces. For example, in the conjoint analysis research using consumers to evaluate various possibilities for the design of a new table radio, respondents had previous experience with the various options considered.[12] It is probably a safe assumption that all of the respondents in the Sands and Warwick study were quite familiar with radios and their various options (e.g. price, bands, plastic or wood finish).

The table radio study is a good example of an "innovation" that may not be an innovation at all. At best, the new table radio could be described as a "continuous innovation," to use Robertson's terminology.[13]

It is more difficult to study true innovations. Since these products do not yet exist, naturally this precludes the possibility of rounding up a knowledgeable sample of consumers experienced with the technology.

From the consumer's perspective, it is assumed that it is not the technology itself which is salient, but rather the gratifications obtained from the technology. For example, other things being equal, the typical home television audience watching Star Wars on their receiver will be indifferent as to whether the film comes to them via pay cable, home VTR, STV, MDS, SMATV, videodisc or off-the-air. Rather it is the characteristics or attributes of the service that are of importance. More important than the delivery mode would be things such as scheduling, cost and presence or absence of advertisements.

One would expect consumers to be knowledgeable about their own communication needs. Further, one might reasonably expect that consumers can make informed judgements about the importance of various communication services and attributes as described to them. It is probably not a very wise idea to expect consumers to be knowledgeable about a range of innovative and non-innovative telecommunication technologies. This is the basic rationale for conducting two studies in this research, one of consumers and one of communication experts familiar with telecommunication technology.

The consumer study used a probability sample of home consumers. Respondents in this study were asked to make judgements about their communication needs and the importance of different types of communication services. In terms of the model (Figure 1), this study was used to collect data to estimate the relationship between the first two measurement spaces--communication needs and attributes.

The second study used a modified Delphi technique to establish the relationship between attributes and telecommunication technologies. A sample of communication experts who were knowledgeable about a number of technologies were asked to make judgements about the extent to which each technology was appropriate for providing the various attributes. The study used two administrations of similar mail questionnaires. In the second administration of the questionnaire, data from the first round were summarized and presented. The goal was to arrive at the best set of estimates based on informed group opinion.

Research Hypotheses for the Consumer Study

A set of hypotheses were developed which were generally derived from the model presented in Figure 1. The hypotheses were tested from the data collected in the consumer study. The hypotheses and a brief rationale for each are presented here.

Hypothesis 1: Communication needs are related to the importance of computer-based telecommunication services.

Rationale: This is the major hypothesis to be tested in this study. If there is an overall relationship between these measurement spaces, one might proceed with more confidence to investigate other statistical relationships which are theoretically derived from this overall proposition.

Hypothesis 2: The more important communication needs are, the more non-innovative communication products and services adopted.

Rationale: Other things being equal, it seems reasonable to expect that those with greater or more diverse communication needs would seek out a

greater variety of attributes than might be accessible in only a few communication products and services. This hypothesis is limited to a consideration of non-innovative entities since the relative innovativeness of a product or service might potentially be an intervening variable in the adoption process.

Hypothesis 3: The more important communication needs are, the more communication innovations are adopted.

Rationale: Essentially, the same rationale as for hypothesis 2 although the premise is changed somewhat. The greater one's communication needs, the less likely that the existing range of products and services are to satisfy this set of needs. In this case, it is more likely that one would look beyond non-innovative alternatives to examine the realm of more innovative offerings.

Hypothesis 4: The more important communication needs are, the more one is willing to pay for a package of computer-based services.

Rationale: Willingness to pay seems to have face validity when considering the relationship between needs and services. If the need for services is greater, one would expect that the economic value of these services to the respondent would increase.

Hypothesis 5: The greater the use of telecommunication media, the more non-innovative communication products and services adopted.

Rationale: One of the indicators of communication needs is the actual use a variety of non-innovative media. The greater or more diverse one's communication needs are, the less likely it is that fewer telecommunication alternatives can adequately serve these needs.

Hypothesis 6: The greater the use of telecommunication media, the more innovative communication products and services adopted.

Rationale: This rationale draws upon the reasoning used in the rationale for the previous hypothesis. One would expect that as needs increase, the respondent would be even more likely to look beyond the present range of alternatives to be motivated to investigate new offerings.

Hypothesis 7: The greater the use of telecommunication media, the more one is willing to pay for a package of computer based services.

Rationale: Economic value of the services is expected to increase proportionate to need. If the frequency of use is a behavioral indication of communication needs, it seems reasonable to predict this relationship between media use and economic value of the services.

Hypothesis 8: The greater the importance of the innovation attributes, the more one is willing to pay for a package of computer-based services.

Rationale: As the salience of various attributes increase in the respondents mind, it seems reasonable to expect that the economic value of these attributes would also increase.

Hypothesis 9: The greater the importance of computer-based services, the more one is willing to pay for these services.

Rationale: On the face of it, it seems that those who find services to be important to them should also be more willing to pay for these services.

Hypothesis 10: Attitudes toward intangible attributes are related to the salience of attributes and services.

Rationale: The first nine hypotheses deal with relatively tangible attributes of innovative and non-innovative communication products and

services. Part of the theoretical approach of this research considers the impact of the attitudes of potential adopters toward the more intangible attributes of communication products and services. It is expected that attitudes toward these intangible attributes do have a bearing on the extent to which various services and tangible attributes are judged as being more or less important. Based on past research, it is expected that measures of convenience and innovativeness should correlate positively and measures of social contact needs and attitudes toward computerization should correlate negatively with the perceived salience of new technologies attributes and services.[14]

Research Questions for the Delphi Study

The second study of communication experts familiar with telecommunication technology was undertaken to estimate the relationship between various services and attributes in the abstract and the concrete technologies which could be used to provide these services. Three main questions were pursued in this study. These questions, and the rationales for their inclusion, are presented below.

Question 1: What is the self-perceived expertise of the sample in terms of the range of telecommunication technologies considered in this study?

Rationale: The purpose of this question was to establish which of the judgements should be used in the final analysis. Judgements from each respondent were included in the final analysis only if that respondent rated herself or himself above the scale mean on a knowledgeability scale.

Question 2: What is the appropriateness of each of a number of telecommunication technologies for providing a variety of computer-based telecommunication services?

Rationale: This is the major question in this study. Respondents were asked to make judgements by rating the appropriateness of several technologies, including some not generally available at the time of the study, for the provision of a number of services.

Question 3: What are the demographics of the communication experts rating themselves as knowledge about telecommunication technologies?

Rationale: The major point here is to describe the background and other characteristics of the sample.

Conclusion

The two study approach seems well justified, given the nature of the model to be tested. It is not reasonable to expect that home consumers will be knowledgeable about a range of telecommunication technologies. According to the model, consumers actually do not need to know that much about the technologies. All that consumers must be able to do is develop a sense of what attributes are important to them. The correspondence between attributes and technologies can be emphasized as part of a marketing drive. If the link between communication needs and the salience of attributes is established, then adoption of technologies providing the preferred collection of attributes can be more confidently predicted. This presumes that the consumer is somehow made aware of the ability of the various technologies to provide the types of attributes and hence gratifications that they are seeking. This final variable was not included in the present study but should be considered in future research.

CHAPTER II

REFERENCE NOTES

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CHAPTER III

METHODS FOR THE HOME CONSUMER STUDY

Research Design

The function of this study was to collect data from home consumers regarding their self-perceived communication needs; attitudes toward the attributes of computer-based telecommunication technologies and household adoption and individual use of communication and information related products and services. A sample survey design was used in this cross-sectional study. A probability sampling procedure was used. In this study, only respondents living in East Lansing households were interviewed. All interviewing was from a central supervised location over the telephone by trained interviewers. The survey data were analyzed using a statistical package on a CDC Cyber 750 Series 170 mainframe computer.

Selection of the Variables

The overall objective of this research was to test the relationship between the communication needs respondents felt were important to them and the perceived salience of various attributes of computer-based telecommunication technologies. If there is an overall relationship between these sets of variables, the implication is that predictions of innovation adoption can be enhanced. Assuming that there is a valid relationship between perceived needs and salience of attributes, it seems plausible that innovations embodying attributes which

correlate positively with needs will be adopted at a greater rate than other innovations.

The prediction of future behavior based on measures of present attitudes is problematical. Measurement of the actual adoption decision regarding computer-based technologies is beyond the scope of the present research. Some measures of household adoption of communication related products and services were included in the final instrument. Theoretically, people with diverse sets of salient communication needs would tend to live in a household with more communication products and services. In addition to household adoption, another behavioral measure considered was individual use of currently available telecommunication and information resources. These behavioral measures were included essentially as checks on the validity of the needs and attributes measures. One would expect that potential adopters would be favorably predisposed toward an innovation prior to adopting it. Therefore, a measure of attitudes or predisposition toward the attributes of innovations should be an effective predictor of eventual adoption.

In the marketing literature, developing and testing models for sales forecasts of new products has occupied much research effort. Typically, in the research a "concept test" for a new product is conducted which aids in developing competitive product positioning strategies. In a "concept test," new products are described to respondents in terms of relatively familiar attributes. Attitudes toward the new product can then be assessed. Product descriptions or concepts are modified until the most favorable reaction is obtained from the respondents.

Implicitly, it is assumed that the product concept which yields the most favorable attitudes will be associated with future purchasing behavior. Future behaviors are thus being predicted on the basis of present attitudes. One telecommunication researcher studied the preferences of elderly populations for interactive cable services. One might question the validity of these data since respondents had no experience with the services. He argued that while respondents were asked to indicate their purchase preferences without having actually used the particular interactive services under study, this design did at least yield valid data regarding pre-purchase preferences. These pre-purchase preferences are then likely to be important predictors of subsequent purchasing behavior.[2] Generally, there is some fairly cogent evidence to support the proposition that attitudes are useful predictors of subsequent behavior.[3]

In the present research, it is assumed that findings relating to the attitudes of respondents toward the attributes of innovations will be useful in predicting subsequent adoption of new technologies which embody these attributes, as they become available in the future. It is much easier to study attitudes as opposed to behaviors regarding innovations because the product need not actually be available in order to conduct research. Obviously, behavioral measures provide the most information about the success of an innovation, but attitudinal research can provide early warning diagnostics before full scale commitments have been made in the product life cycle. Once initial estimates regarding the best mix of preferred attributes have been made, field tests of the innovation prototype would be appropriate. To aid in the prediction of the adoption of telecommunication innovations,

the attitudinal research should proceed by describing the attributes of the innovations in terms considered to be familiar and realistic to the respondents.

Past research would indicate that tangible and intangible attributes of innovations should be considered as a means of enhancing the ability to predict adoption.[4] For this reason, variables representing both the tangible and intangible features of computer-based telecommunication innovations were included in the present design. Several major intangible attributes have been identified in the research literature: (1) attitudes toward computerization; (2) need for social contacts; and (3) need for convenience.[5] By its nature, an intangible attribute is more a property of the perceiver than the perceived. The attitudes of potential adopters along these general dimensions may affect the range of what they consider acceptable in terms of specific innovation attributes. Therefore, by measuring respondents' attitudes along these general dimensions, the quality of predictions incorporating data on attitudes toward specific features of innovations may be improved.[6] Several items in the final instrument were included to encompass these general intangible attributes.

A number of items were included in the final instrument which were designed to collect information about respondents' attitudes toward the tangible attributes of computer-based telecommunication technologies. Although there are potentially hundreds of attributes which could be considered, these attributes tend to fall into just a few categories. A sampling of the salient characteristics of computer-based telecommunication systems found in the literature is presented in Table II. These attributes can be consolidated under headings of: (1) display

TABLE II. SALIENT CHARACTERISTICS OF COMPUTER-BASED TELECOMMUNICATION SYSTEMS IDENTIFIED IN THE RESEARCH LITERATURE

Researcher(s)	Salient Characteristics Identified
Chaffee and Petrick[a]	Storage capacity Access Speed of transmission Amount of information stored/transmitted Reducing information distortion
Sirbu[b]	Record Process (manipulate, modify, transform information) Display/reproduce Store/retreive Communication
Branscomb[c]	Text entry (edit/compose) Replication (display) Storage Search, select, retrieve Communication
Tydeman et al.[d]	Communication network interface User terminal display Input Processing capability Storage Database

[a]Chaffee, Steven H. and Michael J. Petrick, Using the Mass Media, (New York: McGraw-Hill, Inc., 1975), p. 233.

[b]Sirbu, Marvin A., "Innovation Strategies in the Electronic Mail Marketplace," Telecommunications Policy, September 1978, pp. 191-192.

[c]Branscomb, Lewis W., "The Electronic Library," Journal of Communication, Winter 1981, p. 147.

[d]Tydeman, John, et al., Teletext and Videotex in the U.S., (New York: McGraw-Hill, Inc., 1982), p. 159.

attributes; (2) speed; (3) level of user skills required; (4) communication capabilities; (5) input/output features; (6) processing capacity; and (7) storage/retrieval abilities.

While these attributes were operationalized and included in the final instrument, they seem to be fairly technical.[7] An additional index to represent attitudes toward tangible attributes was included in the instrument which was intentionally less technical and, therefore, perhaps more familiar and realistic to the respondents.[8] This index was based on a description of the attributes of possible computer-based telecommunication technologies in terms of the types of services which would be possible to provide. The services selected for inclusion in the instrument have generally been found to be among the more popular services in studies of consumer interest.[9] As an additional measure of interest in these services, respondents were asked how much they would be willing to pay for a package of the computer-based services most important to them.

Another set of variables included in the final instrument was a set of communication needs. The set of items to measure communication needs was developed primarily by reviewing the research literature. The objective was to generate a pool of items which would be valid operationalizations of communication needs. Some items were designed to measure general needs. The other items dealt more specifically with the types of needs which computer-based telecommunication technologies may be well suited to serving.

Probably the definitive work in the area of communication needs research was the landmark study conducted by Katz and his colleagues.[10] In this work, a comprehensive list of social and psychological needs

was assembled. These needs were tested in an attempt to determine whether they could be satisfied by exposure to the mass media. Eventually, these researchers were able to distill a set of thirty-five need statements which were administered to a sample of 1,500 respondents in Israel. The major aim of this study was to explore the relationships between media attributes and the functions served by these media. A significant conclusion based on this research was that different media with different attributes serve different communication needs.[11]

The importance of the communication needs researched by Katz et al. for Israeli citizens has been successfully replicated by researchers working in the United States. The importance of other needs was also established.[12] This research revealed that people do have needs which are satisfied by exposure to the mass media. Furthermore, these needs are differentially satisfied by various media. It appears that the attributes of the medium influence the extent to which each need can be served.

Items to measure the importance of a number of communication needs were selected from this previous research for inclusion in the present study.[13] Only those needs which had been found to be important to the respondents were considered for inclusion in the final instrument. Several other needs, not necessarily directly related to communication were also measured in the final instrument. For example, the need to "take less time with household bookkeeping;" the need to "keep records on household finances organized and up to date;" and the need to "cut down on transportation costs by not going out of the house as often," were included as items. Each of these needs potentially involves the

manipulatation of information and for this reason these needs were included in the survey instrument.

The last major set of variables included in the final instrument related to demographics. Items regarding household variables such as household income, total number of people and number of children in the household were measured. Individual demographics such as age, marital status, length of residence in the East Lansing area education and gender were measured.

Selection of the Sample

The specific nature of the survey instrument used in this study might have made it difficult to obtain valid data from persons who were less verbal or with less education. It was expected that those persons with higher education might be able to provide more valid answers to the somewhat abstract questions in the instrument. In particular, the items regarding the attributes of the computer-based telecommunication technologies might be difficult for persons less used to dealing with abstractions. For this reason, a sample was selected from a population which was known to have a high education skew relative to other populations in the metropolitan area. Past research in the Lansing metropolitan area has indicated that East Lansing residents tend to be better educated than residents in many of the surrounding communities. This is not surprising, given the fact that East Lansing is a university community. The sample used in this study was drawn from the East Lansing universe.

Using a systematic procedure, a random sample of six digit prefixes corresponding to East Lansing telephone numbers was drawn from the 1982-1983 edition of the Lansing area telephone director (issued May 1982). The final digit was generated by using the random number generator function of a hand calculator (Radio Shack EC-4004). This procedure was used to increase the probability of reaching active telephone numbers. The randomly generated seventh digit permits people with unlisted telephone numbers, or those who have recently moved to be reached.

Administration of the Survey

After the variables were selected and operationalized, a survey instrument was drafted. This was pretested by members of an undergraduate research methodology class. Class members were asked to arbitrarily select names from the Lansing area telephone book. Students then called these numbers until they had completed the assigned number of interviews. Students were asked to keep notes of their experiences. On the basis of this input, the wording of the instrument was modified somewhat to produce the final version presented in Appendix A.

Final telephone interviews were conducted by trained student interviewers over a two week period. During the first week, interviews were scheduled from 6:30 to 9:30 p.m. from July 19-22, 1982. During the second week, interviews occurred between 9:00 a.m. and 9:00 p.m. in an attempt to reach those people not available during the first week. Most of the interviewers were from an undergraduate audience survey and analysis class. These students were participating in the study for credit as part of a class project in a research methodology course. Three interviewers were not members of the class, but had other research

courses and field experience. All interviewers received a written set of instructions in addition to an oral briefing on telephone interviewing techniques. The interviewing occurred in a supervised, central location. Anyone over eighteen was interviewed at each telephone number. An attempt was made to equalize the number of males and females in the final sample. Interviews were completed only with individuals living within the city limits of East Lansing. Each interviewer was instructed to ask to speak with a male over eighteen half the time, and with a female over eighteen half the time. If a male was not available, then a female over eighteen would be interviewed, and vice versa.

The distribution of sample survey telephone calls is presented in Table III. The completion rate was 58.92%. A total of 718 telephone calls were made by the interviewers. It was determined that 274 of the telephone numbers reached were not in the sample universe. These numbers were either disconnected; businesses or outside the city limits of East Lansing. Interviewers were instructed to let the telephone ring at least six times before coding the attempt as "no answer." All telephone numbers yielding results or "no answer" or "busy" were called back several times. Some of the callbacks were made during normal business hours (9:00 a.m. to 5:00 p.m.) in a further attempt to reach respondents not available during evening hours.

Sample Demographics

Data regarding the discrete and continuous demographic variables measured in this study are presented in Table IV. As expected, there was a high education skew in the sample. About 90% of the sample had

Table III. DISTRIBUTION OF SAMPLE SURVEY TELEPHONE CALLS

Outcome	Frequency	Percent[a]
Complete	261	58.92
Incomplete	22	4.97
Refusal	22	4.97
No Answer	138	31.15
Disconnected	141	---
Other	133	---
TOTAL	718	100.01[b]

[a]Percentages are based on 443 "valid" attempts to conduct an interview. Telephone numbers that had been disconnected or were not in the universe (e.g. businesses or residential numbers outside of East Lansing) are not included.

[b]Percent does not total to 100% due to rounding error.

at least a partial college education. Nearly a quarter of the sample had studied at the graduate level.

Less than a fifth of the sample households had children. The average number of children in these households was 1.76. Overall, the average household had 3.023 persons. About 40% of the households had incomes of $15,000 or less.

An average age of respondents was 32.607 years. Respondents had lived in East Lansing for an average of 8.992 years. Thirty-seven percent of the respondents were married. In spite of the attempt by the interviewers to equalize the sex ratio of respondents in the sample, the final sample was disproportionately female (55.8%).

TABLE IV. SAMPLE DEMOGRAPHICS

Discrete Variables	Percent (N=261)	Frequency
Marital status		
Married	37.0	95
Single	63.0	162
Children under 12 in household		
Yes	18.9	49
No	81.1	210
Education		
High school or less	10.4	27
Some college	37.5	97
College degree	27.4	71
Graduate work or degree	24.7	64
Income		
$15,000 or less	39.4	97
15,001 to 25,000	19.1	47
25,001 to 35,000	14.2	35
35,001 to 45,000	9.4	23
45,000 or more	17.9	44
Sex		
Male	44.2	114
Female	55.8	144

Continuous Variables	Mean	Median	S.D.
Age	32.607	26.688	15.022
Number of children	1.760	1.559	0.894
Number in household	3.023	2.532	3.292
Length of residence (years)	8.992	4.972	9.470

Data Reduction

To facilitate the analysis of the data summated scales were computed.[14] Two types of scales were created. The first type of scale was based on summing across scores on non-attitudinal items. The other type of scale was based on attitudinal items. Scales of the latter type were further analyzed to assess reliability and underlying factor structures.

Two non-attitudinal ratio level summated scales were computed. These scales represented the extent to which respondent households had adopted (1) non-innovative; and (2) innovative communication products and services. These scales were composed from individual binary items (0=not adopted; 1=adopted). "Innovative" was operationalized as constituting those products and services adopted by less than 15% of the households. Anything adopted by 15% or more of the households was considered to be "non-innovative." A listing of the innovative and non-innovative communication products and services considered in this study are presented in Table V.

Traditionally, innovation researchers have designated "innovators" as the first 2.5% of a population to adopt an innovation.[15] This is an arbitrary designation and in fact, there is some reason to suspect that for various reasons true innovators may not be among the first to actually adopt innovations.[16] In any case, those with the strongest needs should be among the "early adopters," if the innovations considered embody the salient attributes. Together, the "innovators" and the "early adopters" comprise the first 15% of a population to adopte innovations according to innovation researchers.

TABLE V. INNOVATIVE AND NON-INNOVATIVE COMMUNICATION PRODUCTS AND SERVICES

Innovative Products[a]		Non-Innovative Products[b]	
Item	% adopting (N=261)	Item	% adopting (N=261)
Non-Bell phone	13.3*	Television	92.3*
Videocassette recorder	8.5	Color television	76.9*
Videodisc	1.9	Cable television	56.4
Video game machine	12.7	Pay cable	29.8*
Home computer	5.4	Radio	98.8*
Discount toll service	10.0	Telephone	100.0*
CB radio	13.7	Push button phone	54.4
Home intercom	10.8	Tape player (audio)	61.0
		Stereo system	87.3
		Encyclopedia	45.4

*continuous variables, all others are dichotomous (yes/no)

[a]innovative was defined as anything adopted by less than 15% of the sample

[b]non-innovative was defined as anything adopted by 15% or more of the sample

Three summated scales were computed from sets of attitudinal items. Items comprising these scales were assumed to be interval level measures using a four point scale: 4 = very important; 3 = important; 2 = not very important; 1 = not important at all. These items were forced choice, in the sense that no neutral position was offered. The three scales were computed from individual scores on the NEEDS items (Appendix A: items 5a-5o); SERVICES items (Appendix A: items 8a-8n); and the FEATURES items (Appendix A: items 10a-10g).

The validity of each scale was assessed by examining the face validity of each item. Validity is difficult to objectively assess. The reliability of each scale is more amenable to statistical analysis. Theoretically, each scale item is randomly drawn from a universe of items representing a theoretical content domain. The scale is an operational construction of this domain. The total set of items comprising a scale is, therefore, equivalent to a random sampling of possible items. This assumption corresponds to the domain-sampling model of measurement error.[17]

There are many potential sources of error in the computation of scale scores, some external to the scale and some internal. For example, scores may be a function of respondent fatigue, response set, or interviewer bias. Assuming that these sources of errors are either random or negligible due to the effectiveness of the research design, the other major source of measurement error is due to the sampling of items to be included in the final scale. The extent of this error is predictable from the average inter-item correlation of scale items.

According to the domain sampling model, if every possible scale item was included, there would be no measurement error due to item sampling. Of course, it is impractical to reduce error in this fashion. The objective is to create a scale with as few items as possible while minimizing error due to content sampling. When error is sufficiently minimized due to content sampling, the resulting scale is said to be reliable. If the items comprising a scale represent a good sample of the content domain, then there should be a good deal of internal consistency among responses. The average inter-item correlation can be used to conveniently assess the degree of internal consistency or the

reliability with which one item score can be predicted, given knowledge of other items in the scale.

The generally recommended statistical estimate of reliability is coefficient alpha.[18] Coefficient alpha is a function of the number of scale items and the covariance matrix of scale items. Other variations on this basic formulation are possible. Since the factorial structure of these scales was also examined, it is interesting to note that coefficient alpha, as an estimate of reliability based on the domain sampling model of measurement error, retains its value even when the factorial complexity of the data exceeds one.[19] For this reason, it is recommended that prior to performing factor analyses on data sets, the reliability first be assessed.[20]

The internal consistency of the three attitudinal scales was assessed by using the SPSS RELIABILITY subprogram (Version 8.3) to compute Cronbach's Alpha coefficient.[21] In interpreting reliability coefficients, it is recommended that Cronbach's Alpha coefficient should be at least .70 in early stages of research.[22] This standard was applied to the NEEDS, SERVICES and FEATURES scales computed in this research. All three scales were thus evaluated to be reliable, as indicated by the results in Table VI.

Based on the finding that all three attitudinal scales were reliable measures, and with a desire to be as parsimonious as possible, the scale items were used collectively in further data analysis. Exploratory factor analyses were performed on each set of scale items to determine whether there was more than one underlying dimension. Factors are linear combinations of variables in a data matrix. The factor

TABLE VI. CRONBACH'S ALPHA COEFFICIENT RELIABILITY ESTIMATES FOR NEEDS, SERVICES AND FEATURES SCALES

Scale	Number of Items	Cronbach's Alpha Coefficient
Communication Needs	15[a]	.769
Saliency of Computer Based Services	14[b]	.881
Saliency of Features	5[c]	.772

[a]Appendix A: items 5a through 5o

[b]Appendix B: items 8a through 8n

[c]Appendix A: items 10a, 10b, 10c, 10e, 10f and 10g

analyses reported here follow the guidelines recommended by Rummel;[23] Weiss;[24] and Smith and Blashfield.[25]

The factor analyses were all executed using the SPSS FACTOR subprogram (Version 8.3).[26] The basic steps of a factor analysis are: (1) the preparation of an initial correlation or similarity matrix; (2) extraction of initial factors; and (3) rotation of factors to a terminal solution. There is a variety of algorithms which offer variations in the way these basic steps of factor analysis are carried out.

The initial data matrix in these analyses was a persons (rows) by variables (columns) matrix. Pearson product-moment correlation matrices were calculated from these data. The correlation matrix in each case was based upon relationships among the variables. Factor analyses using this type of similarity matrix as input are known as "R-type" factor analyses. Listwise deletion of cases with missing data was employed in the algorithm.

The extraction of initial factors was based on the classical or common factor algorithm. Here, it is assumed that there is an underlying regularity in the data. Essentially, it is assumed that the scale items are actually measuring underlying hypothetical or inferred factors. These inferred factors are mutually orthogonal. In this method, variance among variables is partitioned into that which is common (e.g. explained by the inferred factors) and that which is unique (not explained by factors). Classical factor analysis seeks to decompose the factorial structure of only the common variance.

The decomposition of common variance is accomplished by replacing the unities in the main diagonal of the similarity matrix with communality estimates (e.g. common variance) prior to the extraction of initial factors. The SPSS FACTOR subprogram option of principal factoring with iteration was selected for this analysis. In this procedure, the communalities are estimated using an iterative process derived initially from using R^2 estimates in the principal diagonal after first determining the number of factors to be extracted from the unreduced correlation matrix. The subprogram follows a rule of thumb and retains for subsequent rotation only those unrotated factors with eigenvalues of greater than or equal to 1.0.[27] This ensures that each factor which is extracted from the common variance of the items will account for at least as much variance as an individual item.

Factors are successively extracted from the reduced matrices by using new communality estimates based on the variance accounted for by extracted factors. This iterative procedure continues until successive estimates of the communalities are approximately equal. This then is the best estimate of the communalities.[28]

Having extracted the principal common factors, the last step in a factor analysis is the rotation of these factors in an attempt to create a simple and interpretable solution. Usually, the first factor to be extracted is a general factor because it correlates or loads highly on most of the variables. Successive factors tend to be bipolar, or have an equal number of positive and negative loadings. These factors can be rotated in a number of ways.

The VARIMAX method of orthogonal rotation was selected here. In this method, variables are forced to load higher on some factors and lower on the others. Factor loadings or correlations between the original variables and the factors. In this way, the factorial complexity of each item is reduced. Ideally, each item will load highly on one factor. The inferred nature of factors can be described by examining those variables which have high loadings on each factor. The character of the underlying structure can be expressed by examining what the variables loading on each factor have in common. In this way, factors can be named on the basis of those variables having high loadings on each factor. Loadings which are .30 or above are typically considered to be high loadings.[29] If a variable loads highly on more than one factor, its factorial complexity is said to be greater than one. This means that the variable has more than one theoretical dimension.

One application of factor analytic techniques is to use the hypothetical factor as substitutes for the larger number of a priori variables in subsequent analyses. The a priori variables are those items actually measured in the instrument. Some would argue that this type of application is one of the more promising developments in

multivariate analysis because of its simplicity and power.[30] In the case of hypothetical or inferred factors, the scores of people on the factors can only be estimated and not perfectly predicted because of the existence of unique variance. The method most commonly used to estimate factor scores is a multiple regression technique.[31]

Factor scores can be estimated for each case on the basis of all variables or just the subset of variables which load highly on each factor (e.g. loadings greater than or equal to .30). The weighted linear combinations of this subset of variables most efficiently estimates the factors.[32] Using the SPSS program, factor scores can be estimated from subsets of variables for each case by using the COMPUTE statement to create linear combinations of those variables with high loadings on the respective factors.[33]

Results of factor analyses

Factor score coefficient matrices were computed for the NEEDS and SERVICES scale items. The FEATURES items were treated as a unidimensional scale as there was no underlying multidimensional factor structure in these data.

Looking at the NEEDS items, it can be observed from Table VII that the unrotated factors accounted for 53.9% of the total variance in the variable set. The remaining variance is due to unique or specific variance and errors of measurement.[34] Ideally, sampling error can be minimized by including at least ten cases for each variable used in the factor analysis.[35] This criterion was met in the present research, since all analyses were based upon an initial data matrix composed of 261 cases.

TABLE VII. EIGENVALUES AND PERCENT OF VARIANCE EXPLAINED BY FACTORS IN UNROTATED AND VARIMAX ROTATED FACTOR ANALYSIS OF COMMUNICATION NEEDS

	Unrotated Factors		Rotated Factors	
Factor	Eigenvalue	Pct. Var. Explained	Eigenvalue	Pct. Var. Explained
1	3.761	25.1	3.155	55.8
2	1.893	12.6	1.328	23.5
3	1.318	8.8	.692	12.2
4	1.117	7.4	.475	8.4
Total	8.089	53.9		

Four unrotated factors had eigenvalues which met or exceeded 1.0, in the analysis of NEEDS items. Factor 1 explained 25.1% of the variance in the unrotated solution. Factors 2, 3 and 4 explained 12.6%, 8.8% and 7.4%, respectively, of the variance in the variable set.

To facilitate the labeling of factors and, therefore, make interpretation easier, the factorial complexity of each variable was not allowed to exceed one. Variables were, therefore, considered to load on at most one factor. This assignment was based on the highest loading for each variable on the respective factors, if more than one loading exceeded the criterion value of .30. The factors were then labeled on the basis of which variables were observed to have loaded on each factor.

Factor loadings for the NEEDS items are presented in Table VIII. Based upon these results, the four factors were named according to the overall nature or similarity apparently existing among the variables

TABLE VIII. VARIMAX ROTATED FACTOR LOADING MATRIX OF COMMUNICATION NEEDS

Item[a]	Factor 1[b] (Surveillance)	Factor 2[c] (Home Management)	Factor 3[d] (Time Elasticity)	Factor 4[e] (Diversion)
5a	.63219	.02095	.13513	.02892
5b	.57298	.13843	.07622	-.02119
5c	.71936	-.04890	.08633	-.02544
5d	.09563	.58659	.12973	-.03043
5e	.35390	.26864	.00549	.24450
5f	.71688	.09795	.16343	.04712
5g	.17451	.03121	.21610	.55560
5h	-.04032	.08609	.05414	.56450
5i	.41332	.28217	-.08566	.12637
5j	.11221	.62037	.12009	.06765
5k	.35370	.17927	-.07517	.16781
5l	.32084	.15125	.53110	.11286
5m	.30649	.39017	.00096	.04289
5n	-.01243	.27967	.62593	.20317
5o	-.02221	.56356	.19284	.18123

[a]All items are from Appendix A

[b]Items a, b, c, e, f, i and k load on Factor 1

[c]Items d, j, m and o load on Factor 2

[d]Items l and n load on Factor 3

[e]Items g and h load on Factor 4

which loaded on each factor. All of the variables loading on Factor 1 seemed to be associated with a SURVEILLANCE function.[35] Factor 2 seemed to be related to a theme of HOME MANAGEMENT. Factor 3 was derived primarily from two variables relating to TIME ELASTICITY, or having information available such that it fit into a personal schedule. Finally, Factor 4 seemed to describe a DIVERSION theme. The two variables loading on this factor dealt with the need to "kill time" and "be entertained." This has a good correspondence with earlier findings.[36]

The factor score coefficient matrix for the NEEDS items is presented in Table IX. Factors were estimated on the basis of a linear combination of original variables. Specifically, this linear combination was computed by summing across the products of factor scores and raw scores for each case on those variables identified as loading on the respective factors. Cases with missing data were included by replacing the missing data cell with the item mean. In regression procedures this turns out to be a fairly conservative procedure yet enhances the use of available data.[37] These factor estimates were then used in subsequent multiple regression analyses for hypothesis testing (see Chapter IV).

Two factors emerged from an analysis of the SERVICES items (Table X). The first factor accounted for 40.0% of the variance in the variable set. The second factor accounted for an additional 10.3% of the variance. After VARIMAX rotation, the factors accounted for 84.9% and 15.1%, respectively, of the common variance.

Factor loadings are presented in Table XI. The first factor seemed to describe an INFORMATION TRANSACTION FACTOR. The items which loaded on the second factor had a common theme of STATUS MONITORING. These

TABLE IX. FACTOR SCORE COEFFICIENT MATRIX OF COMMUNICATION NEEDS[a]

Item	Factor 1	Factor 2	Factor 3	Factor 4
5a	.20465	-.06543	.04523	-.01684
5b	.17237	.02931	-.01152	-.06086
5c	.30273	-.11307	.02657	-.07025
5d	-.02325	.28777	.01146	-.10368
5e	.08588	.08504	-.09182	.12622
5f	.29169	-.03472	.06281	-.02327
5g	.01667	-.08561	.06036	.40104
5h	-.03907	-.01573	-.04704	.38981
5i	.10362	.10664	-.13195	.06124
5j	.09186	.32749	-.02138	-.03345
5k	.08175	.05346	-.10946	.08822
5l	.05033	-.03113	.34178	-.01813
5m	.06253	.15526	-.07687	-.00928
5n	-.09167	.05330	.49443	.04732
5o	-.07682	.27245	.03220	.05591

[a]Underlined factor score coefficients in each column are used to estimate respective factors in subsequent multiple regression analyses (items with highest loadings on each factor).

TABLE X. EIGENVALUES AND PERCENT OF VARIANCE EXPALINED BY FACTORS IN UNROTATED AND VARIMAX ROTATED FACTOR ANALYSIS OF SALIENCY OF COMPUTER BASED SERVICES

	Unrotated Factors		Rotated Factors	
Factor	Eigenvalue	Pct. Var. Explained	Eigenvalue	Pct. Var. Explained
1	5.600	40.0	5.053	84.9
2	1.441	10.3	.902	15.1
Total	7.041	50.3		

two factors generally serve as an independent replication of the tentative results found in previous focus group research.[38] The factor score coefficient matrix for these items is presented in Table XII. Again, this matrix was used to estimate factors in subsequent multiple regression analyses.

The results of the factor analysis for the FEATURES items are indicated in Table XIII. It can be observed that a single factor emerged which accounted for only 44.1% of the variance in the variable set. Based on these results, it was decided to abandon the factor analysis of these items and instead use the unidimensional FEATURES scale in subsequent analyses. This scale was previously determined to be reliable (see Table VI).

Analytical Techniques Used in Hypothesis Testing

Three inferential statistical procedures were used for the testing of research hypotheses: Pearson product-moment correlation; multiple regression; and canonical correlation. The alpha level was set to .05 for all tests. Two of these techniques, correlation and regression,

TABLE XI. VARIMAX ROTATED FACTOR LOADING MATRIX OF SALIENCY OF COMPUTER BASED SERVICES

Item[a]	Factor 1[b] (Information Transaction)	Factor 2[c] (Status Monitoring)
8a	.09852	.66335
8b	.33339[d]	.34356
8c	.24715	.63652
8d	.30685	.60962
8e	.46921	.25935
8f	.54937	.10165
8g	.72817	.18041
8h	.57351	.23995
8i	.52403	.43946
8j	.66877	.42567
8k	.68858	.12880
8l	.41910	.23865
8m	.21754	.68149
8n	.58163	.35468

[a]All items are from Appendix A.

[b]Items b, e, f, g, h, i, j, k, l and n load on Factor 1.

[c]Items a, c, d, and m load on Factor 2.

[d]Item b has approximately equal loadings on the two factors, but is more interpretable when considered as loading on Factor 1.

TABLE XII. FACTOR SCORE COEFFICIENT MATRIX OF SALIENCY OF COMPUTER BASED SERVICES[a]

Item	Factor	Factor
8a	-.13108	.29007
8b	.03212	.05384
8c	-.07499	.25350
8d	-.03297	.22392
8e	.08184	.00369
8f	.13030	-.06241
8g	.28820	-.12323
8h	.13377	-.02372
8i	.05596	.07519
8j	.23260	.06287
8k	.22922	-.10609
8l	.06656	.00550
8m	-.08866	.30419
8n	.14251	.02591

[a]Underlined factor score coefficients in each column are used to estimate respective factors in subsequent multiple regression analyses (items with highest loadings on each factor).

TABLE XIII. EIGENVALUE AND PERCENT OF VARIANCE EXPLAINED BY FACTORS IN UNROTATED FACTOR ANALYIS OF SALIENCY OF FEATURES[a]

Factor	Eigenvalue	Pct. Variance Explained
1	3.084	44.1

[a]Since there was only one Factor, no rotation was performed.

are quite popular in the social sciences. Canonical correlation is less well known.[39] Descriptions of the basic computational algorithm for canonical correlation are now available to those less mathematically sophisticated. Another reason for the rise in interest with this procedure is the advance of high speed digital computers which are well equipped to handle the interative routines in the computational algorithm.

The SPSS (Version 8.3) PEARSON CORR and REGRESSION subprograms were used for the tests involving correlation and multiple regression. In both subprograms, an option was available which permitted item means to be substituted for missing data. This option was selected. The practice of "plugging" missing data cells with item means is a useful way to take advantage of as much data as possible without distorting the results. When the proportion of missing data is small (e.g. less than 5-10% of the cases), this is an especially effective technique for maximizing the use of available data.[41]

To perform the canonical correlation analysis, the SPSS (Version 8.0) MANOVA and CANCORR subprograms were used.[42] Like the Pearson product-moment correlation, canonical correlation seeks to describe relationships

between variables. The Pearson coefficient is limited to the simultaneous consideration of only two variables. On the other hand, canonical correlation can simultaneously examine the relationship between two sets of variables. Actually, canonical correlation describes relationships within as well as between the two variable sets.[43]

There are five basic steps in the computational algorithm for canonical correlation analysis.[44] First, a Pearson product-moment correlation matrix is formed. This super-matrix contains four inter-correlation sub-matrices representing within-set correlations (Set I variables with Set I variables; Set II variables with Set II variables and between-set correlations Set I with Set II variables). Although four submatrices are computed, two of these matrices are actually transpositions of the other two.

The next step is to form the basic canonical relationship matrix. From this matrix the eigenvalues and associated eigenvectors are extracted. In this sense, canonical correlation analysis is similar to factor analysis. Canonical analysis has been likened to a "double-barreled principal components factor analysis." This is because canonical analysis identifies the components of one variable set which have a strong linear relationship to the components of the other variable set.[45] Once the eigenvectors have been extracted, they are normalized to produce a matrix of beta weights or "canonical weights." These weights are applied to the raw scores to produce the linear composites or canonical variates which correspond to principal components in factor analysis. Finally, the canonical component loadings are computed. These loadings, like factor loadings, represent the correlation between the original variables and the canonical variates.

In short, canonical correlation analysis produced a set of weights for each set of variables. Set I and Set II weights are applied to the respective variable sets to create linear composites which can best summarize variance among items with each set. As in factor analysis, there may be residual variance which can be explained after the first root or solution has been extracted. The maximum number of roots which can be extracted is equal to the number of variables in the smaller of the two variable sets. The canonical correlation is computed by simply performing a Pearson product-moment correlation between successive pairs of canonical variates.

When interpreting the results of canonical analysis, most researchers in the past have turned to the canonical weights to assess the importance of the original variables in determining the canonical variates. It has been effectively argued that weights are typically less stable estimates than the canonical loadings. For this reason, it is generally advised that the canonical loadings and not the canonical weights be used for interpretation.[46]

The amount of variance which is predictable in one set of variables, given a knowledge of the other set is asymmetric. The analysis of shared variance between the variable sets is known as "redundancy analysis." The redundancy index provides a measure of shared variance or that variance which is predictable from one set to another.[47] Since the explained variance between sets is asymmetric, sometimes the two variable sets are explictly defined in terms of being the independent and dependent variable sets.

The SPSS CANCORR subprogram provides canonical weights but not the canonical loadings. This subprogram does provide some useful statistics,

such as Bartlett's chi-squared test which is used to assess the significance of the roots.[48] Wilk's lambda statistics is also used to assess significance. The SPSS MANOVA subprogram was used to compute the canonical loadings and to perform redundancy analysis.

CHAPTER III

Reference Notes

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[8]See items 8a - 8n in Appendix A.

[9]The services included in the instrument are based upon findings of consumer interest from surveys conducted by Arbitron and Video Probe Index (1980) and Denton and Bowles, 1980). These, and

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CHAPTER IV

HOME CONSUMER STUDY: RESULTS OF HYPOTHESIS-TESTING

In this chapter, the results of the statistical analyses used in hypothesis-testing are presented. Each hypothesis is stated and then the data are interpreted in light of the statistical model used for the analysis. An alpha level of .05 was specified prior to data analysis.

Hypothesis 1: Communication needs are related to the importance of computer-based telecommunication services.

To test this hypothesis, a canonical correlation analysis was performed on two clusters of variables. Set I variables were the SERVICES items (Appendix A: 8a-8n). Set II variables were the NEEDS items (Appendix A: 5a-5o). Canonical correlation analysis was selected to test this hypothesis because it is the most efficient technique for simultaneously examining the relationship within and between two sets of variables.

Two roots were significant in the canonical analysis. A third root had an associated probability of .059, but this exceeded the criterion value of .05 and, therefore, was not interpreted. The Root 1 canonical correlation was .651. The second root had a canonical correlation of .469. While there are no generally accepted standards to aid in the interpretation of canonical correlation coefficients, both roots were statistically significant far beyond the .05 level. Therefore, the first hypothesis is considered to be supported by statistical significance.

TABLE XIV. CANONICAL CORRELATES OF COMMUNICATION NEEDS AND SALIENCY OF COMPUTER BASED SERVICES

	Root 1	Root 2
Canonical Correlation	.651	.469
Eigenvalue	.424	.220
Bartlett's Chi Squared	370.275	242.018
Degrees of Freedom	210	182
Significance	p=.000	p=.002

In considering the substantive significance of these findings, it makes sense to consider the extent to which there is shared variance between the two variable sets. Simply squaring the canonical correlation coefficient does not provide an adequate index of variance shared between the variable sets. This is because the squared canonical correlation coefficient represents only the amount of shared variance existing between the canonical variates and not the actual variance extracted from the two sets of variables.[1]

An index of shared variance between variables sets has been proposed. This index serves as a guide in assessing the substantive significance of a canonical correlation. For example, a canonical correlation of .66 may be accounting for only 4% of the shared variance between the sets of variables.[2] This redundancy index of shared variance between variable sets can be interpreted in the same way as the squared multiple correlation coefficient used in multiple regression analysis. The redundancy index is equivalent to the average squared multiple correlation coefficient between Set I and Set II variables.[3]

The redundancy index is asymmetric which means that the amount of variance predictable from one set to the other varies.

In the examination of the total redundancies presented in Table XV, it can be observed that 16.391% to 25.172% of the variance between the two sets of variables is shared. Based upon this amount of shared variance and a recommendation that canonical correlation coefficients of larger than .30 be considered as non-trivial, these results are assumed to have practical as well as statistical significance.[4]

Further interpretation of the canonical analysis can proceed by examining the relationship of the original variables to the canonical variates. The canonical loadings are measures of this relationship. Like factor loadings, canonical loadings of .30 or greater in magnitude are of interest when evaluating the results. Looking at the loadings for the Root 1 solution in Table XV, it can be seen that all of the Set I variables have high loadings on the canonical variate for the set. Only five of fifteen items in Set II did not load on the Root 1 canonical variate for this set. This indicates that the Set I variables have strong linear relationships both among themselves (within-set) and with the Set II variables (between-sets). A substantial subset of the Set II variables (ten of fifteen items) exhibit similar characteristics. Generally, there is a strong linear relationship between all of the services and nearly all of the needs.

More specificially, communication needs relative to the importance of current events; useful information; government information; understanding the U.S. and world; and talking with friends and relatives are not strongly related to the Set II canonical variate. These needs are

TABLE XV. CANONICAL LOADING MATRIX OF COMMUNICATION NEEDS AND SALIENCY OF COMPUTER BASED SERVICES

Item		Root 1	Root 2
Set I:	Computer Based Services		
8a.	Fire and burglar alarm	.441[a]	-.522
8b.	Interactive video games	.523	-.320
8c.	Utility meter reading	.477	-.263
8d.	Energy management	.464	-.033
8e.	Home voting	.541	-.208
8f.	Interactive instruction	.526	.187
8g.	Electronic library	.659	-.183
8h.	Electronic mail	.510	-.230
8i.	Balance inquiry	.730	.208
8j.	Electornic funds transfer	.892	.189
8k.	General database	.706	-.117
8l.	Pay per view movies	.509	-.261
8m.	Medical alert	.496	-.313
8n.	Electronic spreadsheet	.687	.080
	Redundancy	15.082%	1.309%
Set II:	Communication Needs		
5a.	Current events	.169	-.198
5b.	Useful information	.242	-.378
5c.	Government information	.117	-.456
5d.	Less time on errands	.670	.097
5e.	Relax and reduce tension	.305	-.047
5f.	Understand U.S. and world	.184	-.478
5g.	Be entertained	.567	-.030
5h.	Kill time	.345	.013
5i.	Improve myself	.321	.264
5j.	Less time bookkeeping	.542	.092
5k.	Talk with friends and relatives	.041	-.218
5l.	Current information	.431	-.414
5m.	Household finances organized	.467	-.244
5n.	TV match personal schedule	.483	-.538
5o.	Reduce transportation costs	.586	.054
	Redundancy	16.635%	8.537%

Total redundancy: Set I given Set II = 16.391%; Set II given Set I = 25.172%

[a]Coefficients equal to or greater than .30 are considered to load on the root.

more closely related to a subset of services in the Root 2 solution. However, the theoretical nature of the Root 2 solution is rather difficult to explain. For example, there seems to be no meaningful way to account for the strong linear relationship existing between the need to have television matching a personal schedule and the importance of having a medical alert service. Since canonical correlation identifies statistical structures and not theoretical structures, this type of result is not unexpected. Researchers are advised that when these results do occur it may be better to ignore the relationship expressed by that particular root and avoid the temptation to overinterpret the results.[5]

Overall, the canonical analysis serves to indicate that all of the services are useful for serving most of the needs. Some needs would appear to remain unserved or at least underserved even if technologies were adopted that could provide all of these services.

Hypothesis 2: The more important communication needs are, the more non-innovative communication products and services adopted.

A principal factors multiple regression procedure was used to test this hypothesis. The NEEDS items were factor analyzed using a principal factors algorithm. Factor scores were computed for each case. Factors were estimated by creating a linear combination of those variables loading highly on each factor. The four principal factors identified in the NEEDS items (see Chapter III) were: (1) SURVEILLANCE; (2) HOME MANAGEMENT: (3) TIME ELASTICITY; and (4) DIVERSION. The results of this multiple regression are contained in Table XVI.

TABLE XVI. MULTIPLE REGRESSION OF NUMBER OF COMMUNICATION PRODUCTS AND SERVICES ADOPTED ON COMMUNICATION NEEDS

Predictor Variable	B	Beta	Standard Error B	Univariate F	r^2 Change
Surveillance Factor	.238	.028	.560	.181	.003
Home Management Factor	.238	.046	.351	.460	.010
Time Elasticity Factor	1.00	.108	.632	2.513	.020
Diversion Factor	-.767	-.079	.624	1.508	.006
Overall R^2 (adjusted) = .005		F = 1.310		df = 4,256	p = .267

The results are not statistically significant at the .05 level and so the hypothesis is not supported. Less than one percent of the variance (adjusted R^2 = .005) was explained. An adjusted estimate of explained variance or the "shrunken R^2" is reported here because this is a better estimate of the population parameter. The adjusted R^2 statistic is smaller than the biased sample estimate of explained variance. The amount of shrinkage is a function of the (1) initial size of the sample R^2; (2) number of predictor variables entered into the multiple regression equation; and (3) sample size.[6] In any case, the R^2 is small and any relationship observed among the variables is probably due to random sampling error.

Hypothesis 3: The more important communication needs are, the more communication innovations adopted.

The overall multiple regression equation for this hypothesis was not significant (Table XVII). However, the hypothesis is partially supported by the finding that the TIME ELASTICITY principal factor is a significant predictor of the number of communication innovations adopted. This principal factor accounted for 2.4% of the explained variance (unadjusted) in the sample data. Overall, the predictor set would be expected

to account for 3.8% (adjusted) of the variance in the criterion measure in the population.

TABLE XVII. MULTIPLE REGRESSION OF NUMBER OF INNOVATIONS ADOPTED ON COMMUNICATION NEEDS

Predictor Variable	B	Beta	Standard Error B	Univariate F	r^2 Change
Surveillance Factor	-.09	-.060	.107	.841	.000
Home Management Factor	.036	.036	.067	.285	.006
Time Elasticity Factor	.303	.170	.121	6.262*	.024
Diversion Factor	.020	.011	.120	.029	.003

Overall R^2 (adjusted) = .038 F = 2.145 df = 4,256 p = .076

*p = .013

These results indicate that the major reason respondents adopted innovative products was for time management applications. Innovations which offer respondents the ability to manipulate time to their advantage are, therfore, likely to be more interesting to potential adopters. The other three principal factors were not significant predictors in this equation. This indicates that none of the innovations identified in the study are related to these needs. Since these are substantial needs, one conclusion might be that innovations designed to serve these needs are likely to be favorably received by potential adopters. Before such innovations are adopted, they would need to provide functional equivalence or superiority at a cost level similar to their present way of serving these needs. It appears that innovations capable of serving the TIME ELASTICITY needs actually are adopted.

Hypothesis 4: The more important communication needs are, the more one is willing to pay for a package of computer-based services.

The multiple regression equation for this hypothesis attained overall statistical significance and so the hypothesis was supported (Table XVIII). The predictor variable set accounted for 4.9% (adjusted) of the variance. Again, only one of the principal factors, TIME ELASTICITY, was significant. The HOME MANAGEMENT principal factor approached statistical significance but did not meet the preset criterion value. The DIVERSION factor also approached significance but did not reach the prescribed level.

TABLE XVIII. MULTIPLE REGRESSION OF AMOUNT WILLING TO PAY FOR SERVICES PACKAGE ON COMMUNICATION NEEDS

Predictor Variable	B	Beta	Standard Error B	Univariate F	r^2 Change
Surveillance Factor	-.089	-.052	.110	.652	.001
Home Management Factor	.115	.112	.069	2.781	.021
Time Elasticity Factor	.307	.164	.124	6.102[a]	.022
Diversion Factor	.175	.090	.123	2.013	.020
Overall R^2 (adjusted) = .049		F = 4.384		df = 4,256	p = .002

[a] $p = .014$

The TIME ELASTICITY factor is again an important predictor, this time for the amount of money respondents said they would be willing to pay for a package of computer-based services. The need to deal with time on a fungible basis is seen to be a predominant need to which

existing innovations are applied. The evidence for this was seen in the testing of the previous hypothesis. Evidently, this need is presently underserved or unserved as it is a major predictor of the willingness to pay for new as well as existing products and services.

Hypothesis 5: The greater the use of telecommunication media, the more non-innovative communication products and services adopted.

These results were not statistically significant (Table XIX). Virtually no variance in the criterion variable was explained by the predictor set (adjusted R^2 = .007). The premise of this hypothesis was that a measure of the actual use of telecommunication options might be an indication of the tendency to adopt products. Those with greater tendencies to rely on media would theoretically adopt more media. The facts do not bear this out however.

There is at least one competing hypothesis to explain these data. The adoption measure used in this equation is a household measure, while the use measure is based on the individual as the unit of analysis. Obviously, individual usage patterns do not predict household adoption. Individual usage patterns are more likely to predict household adoption of non-innovative services, only if the individual is a major decisionmaker in the shouldhold in this study, it was not determined whether the respondent was, in fact, a decisionmaker.

TABLE XIX. MULTIPLE REGRESSION OF NUMBER OF COMMUNICATION PRODUCTS AND SERVICES ADOPTED ON MEDIA USE

Predictor Variable	B	Beta	Standard Error B	Univariate F	r^2 Change
Library	-.335	-.063	.350	.913	.000
Automatic Teller Machine	-.229	-.054	.268	.726	.000
Telephone/Purchase	.916	.113	.537	2.905	.011
Telephone/Pricing	.488	.090	.345	1.994	.011
Telephone/Personal	-.080	-.068	.076	1.102	.005
Mail/Purchase	-.004	-.000	.474	.000	.003
Mail/Personal	.053	.064	.052	1.023	.002
Television	-.001	-.016	.003	.066	.000
Radio	-.001	-.039	.002	.382	.003
Newspaper	.009	.096	.006	2.22	.009
Overall R^2 (adjusted) = .007		F = 1.196	df = 10,250		p = .294

Hypothesis 6: The greater the use of telecommunication media, the more innovative communication products and services adopted.

This hypothesis was not supported as the overall equation was not significant (Table XX). Perhaps the problem is the use of two units of analysis, as noted in the previous hypothesis testing. Clearly, individual usage patterns do not serve to predict household adoption of innovative or non-innovative communication products and services.

TABLE XX. MULTIPLE REGRESSION OF NUMBER OF INNOVATIONS ADOPTED ON MEDIA USE

Predictor Variable	B	Beta	Standard Error B	Univariate F	r^2 Change
Library	-.103	-.101	.068	2.301	.005
Automatic Teller Machine	-.284	-.035	.052	.298	.000
Telephone/Purchase	.153	.097	.104	2.139	.008
Telephone/Pricing	-.036	-.035	.067	.292	.000
Telephone/Personal	-.004	-.017	.014	.072	.001
Mail/Purchase	-.164	-.117	.092	3.192	.007
Mail/Personal	.011	.067	.010	1.104	.003
Television	-.000	-.014	.001	.050	.000
Radio	.000	.068	.000	1.137	.002
Newspaper	.001	.078	.001	1.439	.006
Overall R^2 (adjusted) = .000		F = .854	df = 10,250		p = .577

Hypothesis 7: The greater the use of telecommunication media, the more one is willing to pay for a package of computer-based services.

The overall multiple regression equation is significant and, therefore, the research hypothesis may be accepted (Table XXI). A brief examination of Table XXI reveals that only one of the predictor variables is important in the equation. The use of the telephone to collect price information is highly related to the willingness to pay for computer-based services (p = .000). The use of telephone for personal, non-business application approached significance but did not meet the criterion level.

These results seem to have some face validity. The technology most familiar to respondents which will permit interaction is the telephone. It seems logical that present telephone usage patterns can serve to predict the value to respondents of future computer-based interactive services.

TABLE XXI. MULTIPLE REGRESSION OF AMOUNT WILLING TO PAY FOR SERVICES PACKAGE ON MEDIA USE

Predictor Variable	B	Beta	Standard Error B	Univariate F	r^2 Change
Library	-.081	-.076	.069	1.385	.003
Automatic Teller Machine	.054	.064	.053	1.067	.009
Telephone/Purchase	.024	.013	.105	.038	.000
Telephone/Pricing	.246	.225	.068	13.211[a]	.050
Telephone/Personal	.028	.116	.015	3.419	.013
Mail/Purchase	.115	.079	.093	1.523	.008
Mail/Personal	-.012	-.071	.010	1.335	.004
Television	.000	.037	.001	.351	.003
Radio	-.000	-.025	.000	.159	.000
Newspaper	.001	.055	.001	.748	.003
Overall R^2 (adjusted) = 0.057			F = 2.585	df = 10,250	p = .005

[a] $p = .000$

Hypothesis 8: The greater the importance of the innovation attributes, the more one is willing to pay for a package of computer-based services.

This hypothesis is strongly supported (Table XXII). The multiple regression equation is significant beyond the .000 level. The predictor variable FEATURES accounts for 19.5% (adjusted) of the variance in the willingness to pay for computer-based services. Obviously, the price respondents were willing to pay for the services described to them was dependent upon the more technical attributes of these services. Adoption may be dependent upon the presence and respondents' understanding of these attributes.

TABLE XXII. MULTIPLE REGRESSION OF AMOUNT WILLING TO PAY FOR SERVICES PACKAGE ON FEATURES SCALE

Predictor Variable	B	Beta	Standard Error B	Univariate F	r^2 Change
Features Scale	.056	.445	.007	64.067[a]	.198
Overall R^2 (adjusted) = .195		F = 64.067	df = 1,259	p = .000	

[a] $p = .000$

Hypothesis 9: The greater the importance of computer-based services, the more one is willing to pay for these services.

This hypothesis is also strongly supported. The multiple regression equation is highly significant (Table XXIII). Both principal factors are significant predictors at far beyond the specified alpha level. Together, the two principal factors accounted for 21.3% (adjusted) of the variance in the criterion measure.

TABLE XXIII. MULTIPLE REGRESSION OF AMOUNT WILLING TO PAY FOR SERVICES PACKAGE ON IMPORTANCE OF SERVICES

Predictor Variable	B	Beta	Standard Error B	Univariate F	r^2 Change
Information Transaction Factor	.421	.356	.075	31.206[a]	.197
Status Monitoring Factor	.316	.173	.116	7.415[b]	.022
Overall R^2 (adjusted) = .213	F = 36.184		df = 2,258	p = .000	

[a] $p = .000$

[b] $p = .007$

Although this hypothesis was statistically significant and a fair amount of the variance is explained, one has to wonder what variables account for the other 79% of the variance in the dependent variable. Only a fifth of what people are willing to pay for these services can be predicted by how important the services are to them. Other factors such as the perceived availability of cheaper alternatives with near functional equivalence; household income; or psychological variables such as risk-taking or innovativeness may account for the remaining variance. These possibilities might be explored in future research.

Hypothesis 10: Attitudes toward intangible attributes are related to the salience of attributes and services.

This hypothesis is generally supported. Pearson product-moment correlations were computed to test the relationship between various intangible attributes of computer-based telecommunication technologies and their SERVICES and FEATURES (Table XXIV). Eleven of twelve correlations were significant at or beyond the .05 level (one-tailed).

There were four types of intangible attributes measured. These were the attitudes respondents had toward: (1) convenience; (2) social contact; (3) product newness; and (4) computerization. These items were measured using a Likert type scale (Appendix A: 4a-4f). It was predicted that convenience and product newness would be positively correlated and social contact and computerization attitudes would be negatively correlated with the salience of FEATURES and SERVICES.

TABLE XXIV. PEARSON PRODUCT-MOMENT CORRELATION OF INTANGIBLE ATTRIBUTES WITH SERVICES AND FEATURES SCALE*

Intangible Attributes	Services	Features
Shopping trips are inconvenient	.121[a]	.124[a]
Banking trips are inconvenient	.257[c]	.234[c]
Miss people would normally meet	-.117[a]	.006
Try new products and services	.138[a]	.126[a]
Society too computer dependent	-.279[c]	-.162[b]
Computer records threaten privacy	-.139[a]	-.138[a]

*n of cases ranged from 248 to 261

[a]$p < .05$, one-tailed

[b]$p < .01$, one-tailed

[c]$p < .001$, one-tailed

As expected, the correlations between the convenience measures and the FEATURES and SERVICES scales were significant and positive. The ability to do things such as banking and shopping from the home is a likely application of new technologies for adopters. Respondents placed

a high value on the need for convenience. Also positively correlated and statistically significant was the item dealing with a willingness to try new products and services before neighbors or friends. Evidently, just the newness of a product is enough to stimulate interest among some potential adopters.

Three items were negatively related to the scales. The more respondents indicated that they would miss people they would normally encounter on banking and shopping trips by conducting this business electronically from home, the less important the SERVICES. This variable, however, is independent of the FEATURES scale. Perhaps, this is because the FEATURES themselves do not serve as potential alternatives to social encounters but are merely processing options for SERVICES which can supplant an appreciable amount of social interaction.

Also, as expected, attitudes toward computerization were negatively related to SERVICES and FEATURES. The more likely that respondents were to agree that society depends too heavily on computers or that computer records threaten privacy, the less important were SERVICES and FEATURES.

These results indicating that attitudes toward convenience are positively correlated and attitudes toward computers are negatively correlated with SERVICES and FEATURES tend to corroborate earlier work.[7] A note of caution in interpreting these findings is in order. Although these results are statistically significant, the substantive significance may be somewhat lacking. The strongest correlation in these tests yields an explained variance of only 7.78% and the lowest amount of explained variance in a significant correlation is 1.37%. Thus, it appears that although the results attain statistical significance, there remains quite a bit of unexplained variance.

Discussion of Results

These tests indicate that communication needs are substantially related to the salience of various attributes of technologies. When trying to use measures of the extent to which present technologies are adopted, to predict the importance of future technologies, the relationship breaks down. Perhaps, the best present indicator of how people will use new technologies is the telephone (see Table XXI). The use of mass media is not an indication of future usage patterns with innovative technologies. This finding conforms to other work which considered present media usage patterns as predictors of interaction with new technologies.[8]

This previous work differentiated two kinds of communication needs: (1) information-seeking and (2) information habits. Information-seeking is an active process, where people need or want specific pieces of information. Measuring telephone usage patterns seems to be a good indicator and one with some face validity, of the need to conduct information-seeking. Mass media usage tends to be more based on passive habits and less on an active search for information. Therefore, one might predict that the diffusion of computer-based technologies is more likely to follow the example of the telephone as opposed to technologies like the television for which people seem to have different applications.

The major need respondents seemed to be conscious of, with respect to technological alternatives, was the need for managing their schedules. This need was identified as a TIME ELASTICITY factor. The extent to which improvements in convenience are offered by new technologies would seem to be a major consideration in the adoption process. TIME ELASTICITY was a predictor not only of the adoption of innovative but

also non-innovative communication products and services. The TIME ELASTICITY factor also predicted the amount of money respondents were willing to pay for a package of computer-based services which were important to them.

This study asked respondents to estimate which services they would find important to them and how much they would pay to obtain these services. These operationalizations are somewhat abstract. The validity of data which is based on asking respondents the value of services with which they have no experience is perhaps questionnable. Essentially, the measures in this study were "pre-purchase" measures. The "pre-purchase preference" construct was identified by Danowski and Hanneman in similar research.[9] Danowski and Hanneman argued that their data were valid at least to the extent that pre-purchase preferences might predict subsequent purchasing behavior.

The present study seems to have supported this supposition. On the basis of the results obtained here, one can predict that TIME ELASTICITY will explain a significant amount of the variance in adoption behavior regarding innovations. One might argue that TIME ELASTICITY measures can predict pre-purchase preferences which in turn can predict actual purchases of innovations. If this line of reasoning is correct, one might also suspect that TIME ELASTICITY should be able to predict adoption of existing products and services. And, in fact, this is the case. Therefore, it appears that more confidence may be placed in the types of attitudinal measures which are used to predict adoption.

The fact that respondents had other needs as identified in the factor analyses that did not serve as significant predictors is interesting. The other needs did not predict the number of innovative

or non-innovative products adopted nor the amount of money respondents would be willing to pay for computer-based services. Perhaps, respondents are limited to considering the new technologies primarily in terms of time elasticity applications. In this case, change agents might do well to consider educating potential adopters to the ways in which new technologies can be applied to serve these other important communication needs.[10]

CHAPTER IV

Reference Notes

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CHAPTER V

METHODS FOR THE TELECOMMUNICATION EXPERTS STUDY

Research design

The purpose of the second study described in this report was to collect a set of measures to link the attributes and technologies measurement spaces (See Chapter II, Figure 1). A Delphi method was used to survey a group of telecommunication experts who were knowledgeable about technologies used in this field. Members of this group were asked to judge the extent to which an array of telecommunication technologies possessed a number of attributes.

Comprehensive instruments (Appendices B and C) were designed to collect data regarding the ability of telecommunication technologies to support various computer-based services. The services described in the Delphi instrument correspond exactly to those in the instrument used in the survey of home consumers.

The Delphi method was invented about thirty years ago by researchers doing defense work at the Rand Corporation. "Project Delphi" was the name given to a forecasting study sponsored by the United States Air Force. This study employed special techniques to make use of expert opinion in a process of structured group communication.[1]

Delphi studies typically do not employ random sampling methods. Instead, a universe of "experts" is operationalized and then a purposive sample is drawn from this universe. The sample is selected such that those members of the population who are the most expert with

respect to some phenomena, tend to be selected. The participants in a Delphi study are asked to make expert judgements regarding some set of phenomena. Individual estimates are then aggregated to produce a group estimate. The goal of the group estimation process in a Delphi study is to use a group of knowledgeable respondents to produce a reliable and valid estimate of an unknown quantity. This quantity might be a physical entity, such as a date; probability of an event; cost; or performance level. The quantity to be estimated might alternatively be an abstract entity such as a normative judgement which identified value structures.[2]

A rationale for the use of this method is that information which may be more accurate or more objective can be unavailable or prohibitively expensive to obtain. The Delphi technique provides an alternative to forecasting methods whose input parameters are largely subjective individual estimates. The Delphi procedure can be identified in terms of three major components which occur sequentially. First, data are collected from an expert group regarding the estimation of some entity. Second, these data are summarized by the Delphi researcher and the aggregated data are provided as feedback to the expert group. Finally, in light of group feedback, members of the expert group are permitted to reevaluate and perhaps change their original estimates. These basic steps are repeated until there is some kind of consensus or stability (e.g. no change across successive rounds) in this data. Typically, no more than three such iterations will be required.[3]

The underlying philosophy of the Delphi method is that the judgements of individual experts can be improved by exposing each individual to the thoughts of their peers. This process of group communication is

structured such that after an initial round of data collection, these data are summarized and then an opportunity is provided for the experts to examine the distribution of estimates. The nature of the feedback can assume various forms. The type of feedback which is presented to group members can affect their responses in subsequent rounds.[4]

The intent of presenting feedback which summarizes item distributions from the previous round is that once exposed to this information, participants may wish to modify their previous judgements. The feedback process may stimulate any of several reactions by group members. Participants may choose to ignore the feedback and remain with their initial estimates. Group members may also react against the feedback and present a new estimate which is deliberately skewed in an attempt to affect the central tendency of the distribution in a direction they desire. Finally, group members may seek consensus with overall group opinion by revising their original estimates to conform with the central tendency of the distribution. This last outcome is most desirable if the Delphi process is to work effectively. There is some evidence that feedback does in fact tend to stimulate consensus with an expert group.[5]

The inputs to the Delphi produced group estimates are individual judgements which are derived from a non-probability sample. Researchers commonly apply inferential statistics to data obtained from randomly selected samples. Researchers assume this practice of aggregating data to produce estimates of population parameters is justified. The basis for this justification is an application of probability theory to the sampling process. Since Delphi research does not employ probability sampling some other justification is required for the practice of aggregating data to produce a group estimate.

There are several theoretical approaches which have been presented to offer justification and a formal means for aggregating data in Delphi research. The most promising rationale is a "theory of errors" approach.[6] Among other things, this approach offers a mathematical rule for deriving a group estimate from a set of individual responses.

In the theory of errors approach, individual judgements are treated as though they were a set of readings taken from a single instrument which was subject to random error. In this circumstance, the best estimate of an entity should be a measure of the central tendency of the distribution of obtained readings. Additionally, a measure of dispersion, such as the standard deviation, might be useful to construct a confidence interval about a central value.

Data produced from Delphi designs characteristically form lognormal distributions. In this type of distribution, random error is multiplicative rather than additive as in Gaussian distributions. In lognomal distributions, the geometric mean is a more accurate estimate of central tendency than the arithmetic mean. For this type of distribution, the median is usually a close substitute for the geometric mean and may be more convenient to use.

The theory of errors approach assumes that the judgements of experts is erratic and plagued with random error.[7] It also assumes that there is a single underlying "true" parameter which can be estimated by applying human judgement. The theory cannot accomodate the case where there may be two equally valid but different estimates based on different assumptions. In this case, where the distribution may be bimodal, it may be best to proceed as though there were two separate distributions but under mutually exclusive sets of circumstances. If

there is no group consensus, this may be due to a totally unreliable set of readings (e.g. expert judgements), or it may indicate that no valid measure can be obtained for various reasons. Perhaps the current state of knowledge is insufficient to support any type of consensus. Despite a lack of strong theoretical underpinnings, the theory of errors approach is recommended over other alternatives which have been considered. The theory of errors model can usually provide a better fit of accumulated data to point estimates than these other alternatives.

Finally, the theory of errors approach is intuitively attractive because it has the desirable feature of demonstrating the advantage of using the group response over an individual response irrespective of the nature of the physical nature of the process being estimated. In the present research, the theory of errors model is assumed to be operative in the aggregation of individual estimate to produce a group estimate regarding the relationships between attributes and technologies spaces in telecommunication.

The number of iterations a Delphi study goes through is a function of the variability of responses and the feedback process. One effect of the Delphi method is a convergence facilitated by the iteration process. Convergence can be defined as the extent to which greater agreement occurs on successive rounds of data collection. One measure of convergence is the changing distance between the upper and lower quartile values for a given item.[8]

Some would argue that consensus measures do not take advantage of all the information in the distributions.[9] According to this line of reasoning, a measure of stability is more informative than consensus measures. When using consensus measures, iterations are continued

until a consensus is approximately achieved. This is the operational definition of the best possible group estimate. The use of stability measures would have the iterations continue until the distribution of scores was relatively invariant across two successive rounds. When two successive rounds are similar, even without a consensus (e.g. bimodal distribution), this represents the best judgement of the group. As an avenue of further investigation, the reasons for a lack of consensus might be explored.

In this study, one iteration was performed. Two major factors contributed to the decision to limit the data collection process to two rounds. First, a visual inspection of the data in Tables XXVII-XXXIV reveals some movement in the central tendencies of the item distributions. The measure of dispersion used, the standard deviation, decreased in nearly all cases. This presents a convincing case that greater consensus was being achieved in the second round. The second factor is, perhaps, more practical than theoretical. The attrition rate between Rounds I and II was 40%. At this rate, only 6 or 7 respondents would participate in Round II. A decision was made to base findings on the larger group participating in Round II. According to the theory of errors, the more readings taken, the better, thus it would appear inherently more desirable to use a larger group to produce Delphi estimates.

Instrumentation

This Delphi survey was conducted by mail. The Round I instrumentation is presented in Appendix B. The instrumentation for Round II is contained in Appendix C. These appendices include: (1) cover letters; (2) survey instruments; and (3) follow-up letters.

The cover letter for the Round I administration identified the nature of the project, its sponsor and the purpose of the research. The process of a typical Delphi study was briefly explained and an example was cited from the research literature with which most respondents would be familiar. The output expected from participants was explained. The follow-up letter was sent to everyone in the sample about three weeks after the first mailing to encourage a higher response rate.

The survey instruments for the two rounds of data collection were designed to measure three areas. First, each respondent was asked to rate their own technical knowledge of eight telecommunication technologies and different kinds of terminal devices. Second, respondents were asked to estimate the appropriateness of using each telecommunication technology to provide each type of computer-based service. In this section, respondents were also asked to identify the most appropriate attributes for terminal devices. An interval rating scale was used to consider the appropriateness of the match between the services and technologies. A nominal rating scale was used to assess important terminal attributes (see Appendix B for actual items). Finally, each participant was asked to provide some demographic data.

Three types of scaling methods for close-ended questions have been popular in Delphi instruments such as those used in the present study: (1) ranking; (2) rating; and (3) paired comparisons. To use the theory of errors model an interval level of measurement is assumed. All three of these scaling methods have been found to exhibit interval level properties. Past Delphi research suggests that respondents tend to prefer the rating method using Likert-type scales. Respondents in

this research have indicated that they find rating scales to be fairly comfortable to use in making their estimations.

Respondents in Delphi studies have found simple ranking methods to be fairly uncomfortable for them to use. This seems to be because ranking requires that no two items can be considered equal on the same dimension. This may be an artificial constraint. In the use of pair comparisons with n items, it can be seen that n*(n-1)/2 comparisons must be made. With just twenty items, this would be 190 separate judgements for participants to make. Obviously, this is time consuming and fatigue effects may influence the quality of the data. As noted previously, in the present study, rating scales were selected for the Delphi instruments.

In Delphi research respondents are asked to react to some stimuli presented to them by the researcher. This stimuli might be a situation; a physical event; or some other type of phenomenon. The items in the instrument must present enough detail for the respondent to comprehend the nature of the phenomenon to which she or he is expected to react. It can be a tricky matter trying to present just enough detail to elucidate the problem without providing so much detail that obfuscation becomes inevitable. A lengthy, detailed treatise may tend to obscure rather than reveal the basic premise of the stimuli. On the other hand, too few words may not be sufficient to successfully orient respondents to the phenomena under investigation.

Past Delphi research can offer some guidelines. Experience indicates that test items described with lower and higher numbers of words yield the least consensus while items using medium statement lengths produced the highest levels of consensus.[10] The problem is trying to provide enough detail so that respondents are able to achieve

a common understanding of the stimuli without obscuring the forest for the trees. More words are needed to describe items less familiar to respondents. Statement lengths of twenty to twenty-five words seem to form peak distributions. In the present study, an effort was made to limit statement lengths to these prescribed limits while providing sufficient detail for respondents to make informed estimates. The instruments were pretested,and based on these results, some wording was slightly changed in the final instrument.

Selection of the sample

As considered in Chapter II, the task for the experts in this Delphi study was to make a set of judgements regarding the extent to which specific telecommunication technologies could support a number of services and features. Thus, the expert group would need to be familiar with the range of both the technologies and the services and features contemplated in the study.

The universe of experts operationalized in this study was a special interest group within a major professional association. The Human Communication Technology Special Interest Group (HCTSIG) is composed of academics and industry professionals who are members of the International Communication Association. The HCTSIG maintains a mailing list of its two hundred-fifty members which is updated annually. This mailing list was used as the sampling frame.

As indicated previously, a purposive rather than a probability sampling technique was used in the sample selection process. In this case, the researcher who was a member of the HCTSIG, in consultation with a charter member of the HCTSIG selected from the sampling frame

those individuals thought to be most expert in the relevant areas. From a listing of about two hundred-fifty members, forty-nine were initially selected for the sample. The mailing list had been updated after the most recent annual convention of the association which was held in May 1982. At this time, new members and active members had their listings added or verified. An attempt was made to purge inactive listings from the mailing list. There was no prior indication of how successful this effort might have been.

Since the function of this Delphi study was to substitute expert judgements for direct knowledge, the relative expertise of the respondents was an important issue. The sample was selected on a basis of limited peer review as well as the fact that individuals self-selected into the special interest group. As an additional check, one section of the instrument was used to collect a set of ratings regarding the respondents' own self-perceived expertise in various areas. By limiting the final data set to those estimates obtained from respondents who are judged to be expert in the subject matter by not only themselves, but their peers, the accuracy and validity of the results can be substantially improved.

The use of self-rating scale has been found to be a useful variable to identify the most expert subsample from within the overall sample initially selected. Accuracy of results was improved by using estimates only from expert subgroups selected in this manner. The accuracy of the results were verifiable by a means external to the study because almanac type questions with known numeric answers were used in that Delphi instrument. In this study, the use of self-rated expert subgroups also enhanced the accuracy of results.[11] In terms

of individual responses to items, some further selectivity can lead to superior results. This was found to be true in one study where only those responses which were expressed with a high degree of confidence were included in the summary feedback.[12] As might be expected, the greater the number of respondents who felt highly confident, the better the final distribution of group estimations.[13]

Data regarding the self-perceived expertise of the sample are presented in Table XXV. Respondents were asked to rate their own technical knowledge of nine technologies using a seven point rating scale (1 = not knowledgeable; 7 = knowledgeable). In the responses from Round I, one participant asked that the term "technical knowledge" be further clarified. In the directions for Round II, this construct was operationalized to mean, "the degree to which you are familiar with the capabilities and limitations of each technology described for providing the kinds of services considered in this study." The point was that the respondents were not expected to be capable of designing or building these systems. Respondents, to be considered as experts, were expected to be familiar with technical constraints in terms of applying these technologies to serve human communication needs.

In the final analysis of the Delphi data, only those responses from the most expert subgroups were included. Operationally, this meant that data from respondents rating themselves below the midpoint of the expertise scales were not included in the computation of summary statistics. The operationalization of an "expert" to be any respondent rating themselves above the midpoint of the scale is somewhat arbitrary. Hopefully, the value of this procedure is evident in terms of trying to identify the most expert subgroup for each technology.

Some respondents fit the definition of an expert for some technologies but not for others. In these cases, data were considered from respondents only for those technologies which they had rated themselves as experts.

TABLE XXV. DELPHI RESPONDENTS SELF RATINGS ON KNOWLEDGE OF TELECOMMUNICATION TECHNOLOGIES[a]

Technology	ROUND I (N=20) Mean (s.d.)	ROUND II (N=12) Mean (s.d.)
One-way cable television	5.15 (1.18)	5.25 (1.82)
Two-way cable television	5.00 (1.45)	5.08 (1.73)
Broadcast television	5.30 (1.34)	5.00 (2.05)
Broadcast radio	5.05 (1.28)	4.97 (1.98)
Telephone	5.65 (1.09)	5.58 (1.62)
Direct broadcast satellite	4.90 (1.48)	4.92 (1.56)
Multipoint distribution service	4.15 (1.90)	3.67 (1.72)
Low power television	3.70 (1.84)	3.42 (1.73)
Terminals	6.30 (0.92)	5.92 (1.73)

[a]1 = not knowledgeable; 7 = knowledgeable

Administration of the Delphi survey

This study was conducted by mailing self-administered questionnaires to a sample of forty-nine telecommunication experts identified from a universe of about two hundred-fifty members of the HCTSIG. Two of these questionnaires were returned because the addressee was no longer available at the given listing. Of the remaining forty-seven,

twenty-six people responded to the mailing. Twenty of the returned questionnaires were useable. Three individuals disqualified themselves as experts and three other people felt that the instrument was too long, demanding, confusing or otherwise unworthy of their efforts. The initial mailing contained a cover letter on letterhead stationary and the questionnaire. This mailing went out on August 12, 1982. A follow-up letter urging people to return completed questionnaires was mailed out on September 3, 1982. The initial completion rate of useable returns to total mailings was 40.8%.

Although this was not a random sample, it was desirable to attain the highest completion rate possible to increase the probability that all viewpoints were represented in the data set. There was no way of knowing if those not responding had a systematically different viewpoint or were in fact disqualifying themselves as experts without communicating this to the researcher. Since the instrument was quite comprehensive and demanding, it was likely that only those with a strong interest were willing to complete the questionnaire. From comments received back from the sample it appears that those who were more certain about the content area appeared to be the ones completing the instrument.

Round I data were tabulated and summarized in a convenient form to be presented to the participants as feedback to begin the Round II process. Measures of central tendency and dispersion were provided for each item. The Round II questionnaire was sent to participants on October 14, 1982. A follow-up letter was mailed on November 16, 1982. There were twelve questionnaires returned for Round II. All twelve questionnaires were useable. Since all forty-one members of the

initially selected sample who had not disqualified themselves were invited to participate in Round II, this yielded an effective response rate of 29.3% for this round.

Sample demographics

The demographic data for respondents participating in Rounds I and II are presented in Table XXVI. Although the second round of data collection had only twelve participants, compared to the twenty people in Round I, the demographics for each round are quite similar. The variables measured in this section provide some insight to the type of people who participated in this Delphi survey.

The respondents are predominantly from academia holding ranks of assistant, associate or full professor. There was some representation from outside the academic environment. About a third of the participants had received undergraduate training in a communication related area such as radio/television, mass communication or speech. Those with work outside the communication area came from such disciplines as electrical engineering, English, agriculture, sociology and business.

At the Master's level, there was a greater concentration in the communication area. Sixty percent of Round I respondents had earned a Master's degree in the communication field. A greater percentage of the Round II respondents (75%) had a Master's degree in communication. Finally, at the doctoral level, just about two-thirds of the participants had earned a Ph.D. in a communication field. Overall, twenty-one different people participated in the two rounds. From this total, 71.4% had earned a Ph.D. in some field and an additional 9.5% of the sample were doctoral candidates.

TABLE XXVI. SAMPLE DEMOGRAPHICS FOR TELECOMMUNICATION EXPERTS IN ROUNDS I AND II OF THE DELPHI STUDY

Variable	Round I (N=20) %	Round II (N-12) %
Profession		
Academic	80.0	83.3
Degrees with concentration in communication related area		
B.A./B.S.	35.0	33.3
M.A./M.S.	60.0	75.0
Ph.D.	65.0	66.7
Sex		
Male	95.0	91.7
Participated in Round I		
Yes	---	91.7
Length of membership in HCTSIG (months)		
$\bar{x}$ (s.d.)	20.69 (11.44)	16.78 (9.64)
Number of memberships in technical organizations		
$\bar{x}$ (s.d.)	1.10 (1.02)	1.33 (.707)
Number of memberships in non-technical organizations		
$\bar{x}$ (s.d.)	1.55 (1.64)	1.57 (.787)
Number of technical journals regularly read		
$\bar{x}$ (s.d.)	2.53 (2.32)	2.46 (2.52)
Age (years)		
$\bar{x}$ (s.d.)	36.45 (7.68)	37.75 (8.50)

The comparison of percentages between Rounds I and II may be somewhat misleading. Due to the relatively small samples in this study, a small absolute change in a category tends to reflect a larger relative change. In Round I, for example, each person represents 5% of the total. In Round II, each person represents 8.3% of the total. These data are compared in terms of percentages for ease of relative comparison between and within Rounds.

The participants were predominantly male in both rounds. This may reflect a general male bias in the technology area which may exist for various reasons.[14] Overall, the HCTSIG membership is about 28% female. The originally drawn sample of forty-nine individuals was about 25% female. This proportion corresponds well to the HCTSIG population. While it is not known why people did not respond to the survey, it might be worth noting that two of the three individuals writing to disqualify themselves as experts were female. Perhaps the male concentration in the final sample can be explained by the somewhat greater tendency for females to disqualify themselves as experts, in spite of their interest in this content area.

The average age of the respondents was 36.45 years and 37.75 years, respectively, across the two rounds. Participants had been members of the HCTSIG for 1.72 and 1.40 years across the rounds. The HCTSIG had been in existence for about three years at the time of the survey.

Respondents were members in an average of 1.10 (Round I) and 1.33 (Round II) technical organizations. On the average, participants belonged to 1.55 (Round I) and 1.57 (Round II) non-technical organizations. Technical organizations included groups such as the Institute of Electrical and Electronics Engineers (IEEE) and the Association for

Computing Machinery (ACM). Non-technical organizations were those such as the International Communication Association (ICA) and the Association for Education in Journalism (AEJ).

Respondents regularly read an average of 2.53 (Round I) and 2.46 (Round II) technically oriented journals. Examples of these journals would be publications such as IEEE Spectrum; Communications of the ACM or BYTE magazine. Thus, academic and non-academic publications were considered.

Chapter V

Reference Notes

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[3]Linstone and Turoff, p. 229.

[4]Dalkey, N.D., B. Brown and S. Cochran, "The Delphi Method IV: Effect of Percentile Feedback and Feed-in of Relevant Facts," Rand Corporation, RM-6118-PR, 1970.

[5]Scheibe, M., M. Skutsch and J. Shofer, "Experiments in Delphi Methodology," in Linstone and Turoff, p. 270.

[6]Dalkey, 1975.

[7]Dalkey, 1975, pp. 236-261.

[8]Jones, Chester, "A Delphi Evaluation of Agreement Between Organizations," in Linstone and Turoff, pp. 160-167.

[9]Scheibe et al.

[10]Salancik, J.R., W. Wenger and E. Helfer, "The Construction of Delphi Event Statements," Technological Forecasting and Social Change, 1971, v. 3, pp. 65-73.

[11]Dalkey, N., B. Brown and S. Brown, "Use of Self-Ratings to Improve Group Estimates," Technological Forecasting, 1970, v. 1, pp. 283-291.

[12]Dalkey, N.C., "The Delphi Method: An Experimental Study of Group Opinion," Rand Corporation, RM-5888-PR, 1969.

[13]Dalkey et al., 1970.

[14]Truxal, Carol, "The Woman Engineer," IEEE Spectrum, April 1983, pp. 58-62.

CHAPTER VI

RESULTS OF TELECOMMUNICATION EXPERTS STUDY

The output from this Delphi survey is expected to be of use in planning new applications for telecommunication technology. For example, two-way cable is a relatively new technology which has received some notice in the mass media.[1] The question is whether potential adopters are attracted to the medium itself as a unit or the attributes of the medium. If potential adopters are attracted primarily by the attributes (services and features) then they will tend to adopt those telecommunication technologies which can best provide these salient features.

Consumers typically may not be in a position to judge the relative capabilities of different technologies for supporting their needs and desires. This was the primary function of this Delphi survey, to indicate the extent to which various technologies are appropriate choices for providing the attributes or services consumers most need.

In an attempt to remain as parsimonious as possible in the intitial development of this model, the existence of "modal neutrality" is a basic assumption. Of course, the assumption of modal neutrality among modes of telecommunication may be invalid. Pay-per-view movies may be technically feasible to offer via broadcast subscription television (STV), cable television and multipoint distribution service (MDS). From a communication needs perspective the consumer should be indifferent as to the delivery mode, so long as the service and cost are

similar. For some reason, MDS reception may be inherently more attractive to the potential adopter. The rooftop microwave reception antenna may appear as something mysterious and "hi-tech" to the adopter's neighbors. This may appeal to the adopter because it may lend some kind of prestige. This communicability or observability of innovations has generally been found to be a positive predictor of innovation adoption.[2] In future research, more intangible attributes of this nature should be included in research designs.

In Chapter IV, a major finding was that all of the services and features of computer-based telecommunication technologies were useful for serving some of the communication needs people have. In this chapter, an attempt is made to identify which technologies are best suited to providing these attributes. The assumption is that, ceteris paribus, people will tend to adopt the smallest set of technologies which most efficiently serve their communication needs. This set of technologies must also be attractive in terms of their intangible attributes. To the extent that one technology cannot serve all communication needs, additional technologies will tend to be adopted.

These findings will be presented in terms of the technologies. Thus, each technology will be discussed in terms of its appropriateness for the provision of various services and features, as judged by the Delphi respondents. In this discussion, a technology is considered as an appropriate medium for a particular service only if the central tendency (median and arithmetic mean) of the group estimate was above the scale midpoint on a seven point scale, this midpoint is 4.0. The analysis of terminal attributes will be presented in a slightly different context as nominal rating scales were used. Terminal

attributes rated as appropriate by 50% or more of the sample were considered to be essential for a particular service. Conclusions are based on the data from the second round of data collection.

One-way cable television

Each telecommunication technology was described to the Delphi respondents in terms of its service area; bandwidth capacity; directionality (one-way vs. two-way); and message-type (voice, video, data). One-way cable television has a somewhat limited service area of perhaps one or two towns unless the systems are joined through either hard (physical) or soft (simulated) interconnections.[3] The limited service area is an artifact of the regulatory model for cable television.

Although cable systems built in the early 1980's have bandwidth capacities of up to 450 MHz, many existing cable systems are capable of substantially less bandwidth due to limitations in amplifier technology.[4] Usually, communication systems capable of handling anything more than 3-4 KHz voice grade signals are called broadband circuits.[5] Since the wide bandwidth of cable systems can handle voice, video and high speed data communications, this is truly a broadband communication system. Finally, by definition, one-way cable systems are equipped to handle signals moving in only one direction.[6]

Using the scale midpoint criterion, only two or three services could be supported by one-way cable television systems (Table XXVII). Pay-per-view movies and color signals can be provided and no special user skills such as needing to learn a computer language, are required. The mean for the "user language" item was below the 4.0 criterion ($\bar{x}$ = 3.55). But the median was at the criterion level (Md = 4.0), the

TABLE XXVII. DELPHI RATINGS OF SERVICES AND APPROPRIATE TECHNOLOGIES: ONE-WAY CABLE TELEVISION[a]

	ROUND I			ROUND II		
Service	Median	Mean	S.D.	Median	Mean	S.D.
Fire/burglar alarm	1.13	1.84	1.89	1.00	1.00	0.00
Video games channel	1.45	2.63	2.17	2.38	2.91	1.92
Utility meter reading	1.13	1.90	2.00	1.11	1.64	1.80
Utility load management	1.13	1.74	1.63	1.19	1.64	1.29
Electronic polling	1.09	1.58	1.58	1.05	1.09	0.38
Interactive education	1.19	1.89	1.78	1.29	1.73	1.49
Special interest database	1.36	2.90	2.42	3.00	3.09	1.38
Electronic mail	1.03	1.06	0.24	1.00	1.00	0.00
Balance inquiry	1.13	1.90	2.00	1.05	1.09	0.30
Electronic funds transfer	1.06	1.37	1.38	1.00	1.00	0.00
General interest database	2.75	3.58	2.76	3.88	3.82	1.54
Pay-per-view movies	4.25	4.05	2.55	5.00	4.27	2.24
Medical alarm	1.13	1.95	2.12	1.10	1.18	0.60
Electronic spreadsheet	1.06	1.16	1.79	1.19	1.36	0.67
Color display	6.80	6.06	1.98	6.67	6.50	0.22
Speed	1.10	1.67	1.78	1.63	1.82	0.99
Graphics	1.36	2.53	2.14	2.75	2.91	1.70
User language	5.50	4.19	2.45	4.00	3.55	2.54
Alphanumeric keyboard	1.38	2.00	2.17	1.19	1.73	1.56
Memory/storage	1.11	1.21	0.92	1.00	1.00	0.00
Database management	1.12	1.22	0.94	1.00	1.00	0.00

[a]1 = very inappropriate; 7 = very appropriate technology

distribution was negatively skewed and, therefore, the item was considered to "load" on this technology.

Only one other item approached the criterion. This was general interest database service. Both the median and mean were quite near the criterion value (Md = 3.88; $\bar{x}$ = 3.82). The central tendency measures indicated an increase between rounds of data collection. Based on this trend, the nearness to the criterion value and the researcher's subjective assessment, this item was also considered to load on this particular technology.

Two-way cable television

This telecommunication medium also has a limited service area, due the same constraints which were operative for the one-way system. Two-way cable systems are broadband, bidirectional systems which can carry voice, video and high speed data signals. Typically, upstream communications are allocated to the 5-35 MHz portion of the cable spectrum.[7] This medium is easily judged to be appropriate for the provision of all the services and features considered in this study (Table XXVIII).

Broadcast television

Both very high frequency (VHF channels 2-13) and ultra high frequency (UHF channels 14-69) were considered.[8] Depending upon several variables subject to regulation such as antenna height, power, frequency and other technical factors such as terrain, the service area of this type of technology approximates a metropolitan scale (e.g. radius of fifty miles). The signal is broadband in nature (6 MHz); one-way and capable of carrying voice, video and data communication. There are limitations on the permissible use of broadcast television

TABLE XXVIII. DELPHI RATINGS OF SERVICES AND APPROPRIATE TECHNOLOGIES: TWO-WAY CABLE TELEVISION[a]

	ROUND I			ROUND II		
Service	Median	Mean	S.D.	Median	Mean	S.D.
Fire/burglar alarm	6.75	6.17	1.58	6.30	6.20	0.92
Video games channel	6.68	6.17	1.38	6.50	6.40	0.70
Utility meter reading	6.90	6.56	1.25	6.79	6.70	0.48
Utility load management	6.75	5.72	2.19	6.17	6.20	0.63
Electronic polling	6.81	6.39	1.46	6.50	6.50	0.53
Interactive education	6.75	6.44	0.92	6.30	6.30	0.68
Special interest database	6.60	6.28	0.96	6.50	6.40	0.70
Electronic mail	6.42	6.18	1.07	6.10	6.10	0.74
Balance inquiry	6.60	6.06	1.51	6.17	6.10	0.88
Electronic funds transfer	6.68	5.83	1.98	6.00	6.00	0.67
General interest database	6.60	6.33	0.91	6.25	6.00	1.25
Pay-per-view movies	6.81	6.39	1.29	6.67	6.60	0.52
Medical alarm	6.81	6.33	1.50	6.50	6.50	0.53
Electronic spreadsheet	6.00	4.77	2.56	5.33	5.70	0.95
Color display	6.77	6.50	0.89	6.33	6.22	0.83
Speed	6.65	6.24	1.03	5.50	6.30	0.82
Graphics	6.60	5.78	1.73	6.10	6.00	0.94
User language	6.70	6.06	1.44	6.00	5.89	0.93
Alphanumeric keyboard	6.75	6.33	1.23	6.50	6.50	0.53
Memory/storage	5.50	4.56	2.57	4.83	4.60	1.08
Database management	6.00	4.82	2.53	4.50	4.30	1.16

[a]1 = very inappropriate; 7 = very appropriate technology

signals from a regulatory standpoint. However, the Federal Communications Commission (FCC) was considering action in the spring of 1983 which would open the use of the vertical blanking interval for teletext applications.[9]

This medium was judged to be appropriate for three services and features (Table XXIX). A general interest database; color signals and no special user language were appropriate for braodcast television. Presumably, the Delphi respondents were considering teletext applications for this medium when assessing its appropriateness for the provision of a general interest database service.[10]

Broadcast radio

This medium included both the AM (540-1600 KHz) and FM (88-108 MHz) bands. Like television, the actual service areas of individual stations is dependent upon several regulatory and technical variables such as permitted operating power, frequency, antenna height (FM) and soil conductivity (AM). Generally speaking, most radio stations are capable of serving a small metropolitan area. Some channels in the AM band are cleared from interference and allowed to operate at high power levels such that they can serve a several state area. Broadcast radio is generally considered to be narrowband and one-way. Voice, music, data and slow-scan television signals are possible using this medium.

Group estimates indicate that this medium is not appropriate for any of the services (Table XXX). This is somewhat surprising and an apparent error since the FCC is moving toward lowering of the regulatory barriers against this medium. Radio subcarriers for example, can be used for utility load management and teletext applications which can support at least a general interest database.[11]

TABLE XXIX. DELPHI RATINGS OF SERVICES AND APPROPRIATE TECHNOLOGIES: BROADCAST TELEVISION[a]

Service	ROUND I			ROUND II		
	Median	Mean	S.D.	Median	Mean	S.D.
Fire/burglar alarm	1.00	1.00	0.00	1.00	1.00	0.00
Video games channel	1.23	1.79	1.44	1.21	1.40	0.70
Utility meter reading	1.00	1.00	0.00	1.00	1.00	0.00
Utility load management	1.00	1.00	0.00	1.22	1.40	1.27
Electronic polling	1.13	1.39	1.24	1.00	1.00	0.00
Interactive education	1.14	1.83	1.79	1.21	1.70	1.57
Special interest database	1.36	2.58	2.22	3.50	3.30	1.70
Electronic mail	1.00	1.00	0.00	1.00	1.00	0.00
Balance inquiry	1.03	1.05	0.23	1.11	1.20	0.63
Electronic funds transfer	1.00	1.00	0.00	1.00	1.00	0.00
General interest database	1.75	3.21	2.62	4.50	4.20	2.20
Pay-per-view movies	1.36	2.84	2.52	2.00	2.40	1.58
Medical alarm	1.00	1.00	0.00	1.00	1.00	0.00
Electronic spreadsheet	1.18	1.22	0.94	1.12	1.30	0.68
Color display	6.77	6.00	2.03	6.67	6.40	0.97
Speed	1.06	1.50	1.47	1.21	1.50	0.98
Graphics	1.40	2.50	2.18	1.33	2.10	1.52
User language	6.00	4.25	3.00	4.00	4.00	2.60
Alphanumeric keyboard	1.25	1.93	2.12	1.33	1.80	1.55
Memory/storage	1.00	1.00	0.00	1.00	1.00	0.00
Database management	1.00	1.00	0.00	1.00	1.00	0.00

[a]1 = very inappropriate; 7 = very appropriate technology

TABLE XXX. DELPHI RATINGS OF SERVICES AND APPROPRIATE TECHNOLOGIES: BROADCAST RADIO[a]

Service	ROUND I			ROUND II		
	Median	Mean	S.D.	Median	Mean	S.D.
Fire/burglar alarm	1.00	1.00	0.00	1.00	1.00	0.00
Video games channel	1.13	1.47	1.38	1.25	1.40	0.84
Utility meter reading	1.00	1.00	0.00	1.00	1.00	0.00
Utility load management	1.00	1.00	0.00	1.00	1.00	0.00
Electronic polling	1.07	1.13	0.50	1.00	1.00	0.00
Interactive education	1.12	1.69	1.70	1.21	1.70	1.25
Special interest database	1.12	1.56	1.26	1.33	1.70	1.06
Electronic mail	1.00	1.00	0.00	1.06	1.10	0.32
Balance inquiry	1.00	1.00	0.00	1.00	1.00	0.00
Electronic funds transfer	1.00	1.00	0.00	1.00	1.00	0.00
General interest database	1.15	2.12	2.23	2.50	2.40	1.58
Pay-per-view movies	1.00	1.00	0.00	1.06	1.10	0.32
Medical alarm	1.00	1.00	0.00	1.00	1.00	0.00
Electronic spreadsheet	1.07	1.13	0.50	1.06	1.10	0.30
Color display	1.15	1.29	1.07	1.06	1.10	0.32
Speed	1.07	0.50	1.13	1.13	1.40	0.07
Graphics	1.07	1.38	1.26	1.06	1.10	0.32
User language	5.00	4.13	2.95	3.50	3.30	2.11
Alphanumeric keyboard	1.50	1.86	2.18	1.06	1.10	0.32
Memory/storage	1.00	1.00	0.00	1.00	1.00	0.00
Database management	1.00	1.00	0.00	1.00	1.00	0.00

[a]1 = very inappropriate; 7 = very appropriate technology

Telephone

This technology, the oldest of those considered here, has a virtually unlimited service area. Using twisted pair wire connections with a 3-4 KHz bandwidth capacity (e.g. narrowband), this medium can carry voice, slow-scan video and data communications. It is a fully switched interactive network for communications between two or more nodes. Telephone communications linking three or more points are usually referred to as "conference calls."

This medium was seen to be an appropriate choice for all but three services and features (Table XXXI). Pay-per-view movies, color signals and graphics were not judged to be potential attributes of this technology. The narrow bandwidth does prevent a full motion video service which would eliminate the possibility of pay-per-view movies, unless a hybrid technology (e.g. telephone plus STV for example) was used. However, the telephone is a proven technology for the provision of color signals and graphics. The telephone is a fundamental component in the British interactive videotex system known as Prestel.[12] This interactive videotex service routinely provides color graphics and textual material.

Direct broadcast satellites (DBS)

The service area for this medium depends primarily on the type of transmission beam used. Most proposed DBS services would use spot beam transmission which would correspond roughly to regions the size of time zones in the contiguous United States.[13] This medium is broadband (40 MHz channels) and, therefore, capable of carrying voice, video

TABLE XXXI. DELPHI RATINGS OF SERVICES AND APPROPRIATE TECHNOLOGIES: TELEPHONE[a]

	ROUND I			ROUND II		
Service	Median	Mean	S.D.	Median	Mean	S.D.
Fire/burglar alarm	6.50	5.90	1.45	6.14	6.09	0.83
Video games channel	5.00	4.90	2.00	4.75	4.73	1.74
Utility meter reading	5.75	5.20	1.82	6.33	5.73	1.85
Utility load management	4.50	4.65	2.23	5.75	5.36	1.86
Electronic polling	6.38	5.47	2.04	6.33	6.09	1.04
Interactive education	5.80	4.90	2.21	6.00	4.82	1.72
Special interest database	5.83	4.50	2.65	5.20	5.00	1.55
Electronic mail	6.38	5.47	2.04	6.08	5.73	1.68
Balance inquiry	6.67	6.25	1.21	6.58	6.36	0.92
Electronic funds transfer	6.50	6.30	0.92	6.58	6.36	0.92
General interest database	6.00	4.95	2.33	5.20	4.73	1.68
Pay-per-view movies	1.09	1.84	2.01	1.29	1.91	1.58
Medical alarm	6.88	6.65	0.81	6.71	6.64	0.51
Electronic spreadsheet	5.00	4.16	2.59	5.33	5.27	1.01
Color display	1.17	2.25	2.32	1.33	1.90	1.45
Speed	6.68	5.94	1.73	6.13	6.00	1.00
Graphics	3.50	3.78	2.65	1.75	3.64	1.75
User language	6.68	5.61	2.17	6.50	6.10	1.10
Alphanumeric keyboard	6.60	5.28	2.32	6.13	6.00	1.00
Memory/storage	5.00	4.1	2.77	5.80	5.18	1.78
Database management	5.00	4.15	2.72	4.75	4.73	1.49

[a]1 = very inappropriate; 7 = very appropriate technology

(including high definition video) and high speed data communications. As planned, this service would be one-way.

Group estimates indicated that DBS is appropriate for pay-per-view; color signals and fewer user skills (e.g. no special languages needed). Although not far off the mark, DBS was not seen to be appropriate for the provision of a general database service (Table XXXII). Otherwise, the group evaluated DBS to be essentially the same as one-way cable television.

Multipoint distribution service (MDS)

This technology is associated with a fairly limited service area of perhaps 15-20 miles in radius. It is capable of transmitting broadband signals. With this capacity, voice, video and data communications are possible. Generally, it is configured to be a one-way system, but two-way applications are feasible at least for the business market.

The sample estimated that this technology was suited to four services and features (Table XXXIII). These attributes were a special interest database; pay-per-view movies; color signals and no user language. The provision of a general database came close but did not meet the criterion value. The trend between Rounds I and II was for the general database to be perceived as less appropriate in terms of MDS. Since this trend had a smaller dispersion in Round II, it appears that the group was reaching consensus on this estimation.

Low-power television (LPTV)

The LPTV service was approved by the FCC in March 1982. At that time, about 6,500 applications had been made which could potentially mean an additional 4,000 new television stations. The service area

TABLE XXXII. DELPHI RATINGS OF SERVICES AND APPROPRIATE TECHNOLOGIES: DIRECT BROADCAST SATELLITES[a]

	ROUND I			ROUND II		
Service	Median	Mean	S.D.	Median	Mean	S.D.
Fire/burglar alarm	1.07	1.12	0.33	1.00	1.00	0.00
Video games channel	1.11	1.29	0.77	1.42	2.18	1.78
Utility meter reading	1.07	1.12	0.33	1.00	1.00	0.00
Utility load management	1.03	1.06	0.24	1.00	1.00	0.00
Electronic polling	1.07	1.31	0.87	1.00	1.00	0.00
Interactive education	1.17	1.94	1.81	1.11	1.55	1.51
Special interest database	1.21	2.29	2.20	2.75	3.09	1.92
Electronic mail	1.23	2.19	1.94	1.19	1.27	0.47
Balance inquiry	1.07	1.41	1.46	1.00	1.00	0.00
Electronic funds transfer	1.19	1.35	1.46	1.00	1.00	0.00
General interest database	1.35	2.65	2.34	3.33	3.46	1.92
Pay-per-view movies	3.00	3.65	2.78	4.25	3.82	1.83
Medical alarm	1.13	1.47	1.38	1.05	1.09	0.30
Electronic spreadsheet	1.00	1.00	0.00	1.00	1.00	0.00
Color display	6.69	5.77	2.20	6.50	6.50	0.53
Speed	1.12	2.06	2.29	1.63	2.18	1.72
Graphics	1.39	2.75	2.44	3.00	2.82	1.66
User language	6.00	4.29	3.00	4.50	4.50	2.17
Alphanumeric keyboard	1.90	2.39	2.63	1.19	1.55	1.04
Memory/storage	1.19	1.35	1.46	1.00	1.00	0.00
Database management	1.20	1.38	1.50	1.00	1.00	0.00

[a]1 = very inappropriate; 7 = very appropriate technology

TABLE XXXIII. DELPHI RATINGS OF SERVICES AND APPROPRIATE TECHNOLOGIES: MULTIPOINT DISTRIBUTION SERVICE[a]

	ROUND I			ROUND II		
Service	Median	Mean	S.D.	Median	Mean	S.D.
Fire/burglar alarm	2.00	3.23	2.46	1.50	2.83	2.40
Video games channel	4.25	3.85	2.34	3.67	3.29	2.14
Utility meter reading	2.00	3.31	2.56	1.75	2.43	2.23
Utility load management	2.00	3.23	2.49	2.75	2.86	2.19
Electronic polling	1.50	3.33	2.77	1.38	2.57	2.30
Interactive education	5.50	4.17	2.44	3.50	3.50	2.26
Special interest database	4.75	4.00	2.61	4.00	4.00	2.00
Electronic mail	1.50	3.33	2.57	2.67	3.00	2.19
Balance inquiry	1.31	2.62	2.47	1.50	2.50	2.35
Electronic funds transfer	1.22	2.54	2.50	1.50	2.50	2.35
General interest database	5.63	4.00	2.77	3.83	3.83	1.94
Pay-per-view movies	5.75	4.54	2.70	4.50	4.50	2.59
Medical alarm	1.53	3.00	2.61	1.50	2.33	2.42
Electronic spreadsheet	1.27	1.50	1.73	1.25	1.50	0.84
Color display	6.58	5.64	1.96	6.50	6.33	1.03
Speed	1.36	3.42	3.00	3.50	3.50	2.07
Graphics	1.50	3.17	2.66	3.50	3.83	2.04
User language	6.17	5.00	2.68	5.00	4.80	2.49
Alphanumeric keyboard	1.42	3.64	3.04	3.00	3.33	2.34
Memory/storage	1.55	1.92	2.25	1.50	1.83	0.98
Database management	1.55	1.92	2.25	1.25	1.50	0.84

[a]1 = very inappropriate; 7 = very appropriate technology

for an LPTV station would be limited to perhaps a radius of twenty miles.[14] Technically, LPTV stations are similar to full power television stations. The major difference is in permissible operating power, hence the name low power television.

The group estimates indicate that LPTV is specially suited to only one service, the provision of color signals (Table XXXIV). One might expect that the same attributes ascribed to full power television would be generalized to LPTV. This was not the case.

Terminal design

Terminal devices of some sort are necessary for most if not all of the computer-based services considered in this study. Four basic types of attributes were comtemplated: (1) addressability; (2) microprocessor equipped; (3) keyboard type; and (4) memory. Group estimates regarding terminal design will be discussed interms of these attributes (Table XXXV).

Addressability

In telecommunications, addressability refers to the ability to use digital codes to specify the destination of signals. An encoded digital address in the signal must match a similar address in the terminal before the message can be successfully recieved. Only those terminals with digital addresses matching the coded representation in the message will be able to properly receive the message. One application of this is to enable pay-per-view movies. Only those consumer households with specific digital addresses matching those in the transmitted signal could receive the movie.

TABLE XXXIV. DELPHI RATINGS OF SERVICES AND APPROPRIATE TECHNOLOGIES: LOW POWER TELEVISION[a]

Service	ROUND I			ROUND II		
	Median	Mean	S.D.	Median	Mean	S.D.
Fire/burglar alarm	1,05	1.08	0.29	1.00	1.00	0.00
Video games channel	1.17	1.58	1.44	1.67	1.80	1.10
Utility meter reading	1.05	1.08	0.29	1.00	1.00	0.00
Utility load management	1.00	1.00	0.00	1.17	1.25	0.50
Electronic polling	1.25	1.46	1.51	1.00	1.00	0.00
Interactive education	1.94	2.36	2.34	2.00	2.40	1.67
Special interest database	1.17	1.75	1.55	2.00	2.20	1.30
Electronic mail	1.10	1.18	0.60	1.00	1.00	0.00
Balance inquiry	1.05	1.08	0.29	1.00	1.00	0.00
Electronic funds transfer	1.00	1.00	0.00	1.00	1.00	0.00
General interest database	1.36	2.33	2.02	3.00	2.80	1.30
Pay-per-view movies	1.25	2.58	2.47	2.25	3.00	2.00
Medical alarm	1.10	1.33	0.89	1.00	1.00	0.00
Electronic spreadsheet	1.25	1.46	1.51	1.13	1.20	0.45
Color display	5.50	4.70	2.67	6.33	6.20	1.10
Speed	1.44	1.73	1.62	1.33	1.80	1.30
Graphics	1.29	2.27	2.10	3.00	2.80	1.30
User language	2.00	3.80	3.01	3.75	3.60	1.82
Alphanumeric keyboard	1.75	2.20	2.53	1.63	2.00	2.24
Memory/storage	1.27	1.50	1.73	1.00	1.00	0.00
Database management	1.27	1.50	1.73	1.00	1.00	0.00

[a]1 = very inappropriate; 7 = very appropriate technology

The group estimated that addressability was a key attribute for terminals used to provide almost all of the services. Addressability was not judged to be important for the processing of color signals. There was a split on the need for user languages. Apparently this lack of consensus indicates that at least two different types of applications were being considered among members of the sample. One type of application would require a special user language, while the other, perhaps more sophisticated application would require special user skills.

Microprocessor

A microprocessor is a computer consisting of a central processing unit; memory and an input/output interface. This device may be implemented in one or more chips using large scale integration technology. These devices are relatively cheap. The 16 bit Intel 8088 microprocessor chips sell for under $20 each when purchased in quantity. The cheapness and versatility of these devices make them cost effective for a multitude of consumer applications.

The group estimated that a microprocessor equipped terminal was essential for all but four services: electronic-polling; pay-per-view movies; medical alarm; and color display. Electronic-polling and pay-per-view services are interactive services which are seemingly easier to implement using terminals with on-board microprocessors. The data are not clear as to why the sample estimates did not reflect this.

Keyboard type

Two types of keyboards were considered. A numeric keyboard, perhaps similar to the twelve key pushbutton telephone with ten digits

and two special characters might be one type. Variations in design are possible, but the dominant characteristic of numeric keyboards is that primarily numeric responses are enabled. Alphanumeric keyboards on the other hand permit the user to compose messages using a full character set of letters, numbers and speical symbols.

An alphanumeric keyboard was indicated to be appropriate for fourteen of the twenty-one services. Three services were explicitly identified as needing only a numeric keyboard: electronic-polling; pay-per-view movies and; medical alarm. There was a split regarding the balance inquiry service. This service is commonly implemented in automatic teller machines using only a numeric keyboard.

Memory

The final type of terminal attribute considered was memory. Memory size was not specified. The task for the sample was just the estimation of whether or not any local memory was appropriate for the various services.

Memory equipped terminals were seen to be useful for fifteen services. The group indicated explicitly that memory was not required for five services. Fire/burglar alarms; utility meter reading; electronic-polling; pay-per-view movies and color display were not seen to require local memory capacity in the terminal.

Discussion of results

Trying to determine the suitability of various telecommunication media for the provision of different services can proceed in a number of different ways. An individual researcher might make his or her own subjective estimates. Or a clearly defined set of objective criteria

TABLE XXXV. SELECTION TERMINAL DESIGN ATTRIBUTES BY ROUND[a]

Service	Addressable		Microprocessor		Alphanumeric		Memory	
	I[a]	II[b]	I	II	I	II	I	II
Fire/burglar alarm	88.2	90.0	58.8	60.0	11.8	0.0	23.5	20.0
Video games channel	66.7	90.0	88.9	100.0	72.2	70.0	77.8	90.0
Utility meter reading	87.5	100.0	43.8	70.0	6.3	0.0	25.0	30.0
Utility load management	94.1	100.0	58.8	90.0	35.3	10.0	47.1	50.0
Electronic polling	82.4	90.0	41.2	40.0	52.9	20.0	29.4	20.0
Interactive education	83.3	80.0	83.3	70.0	94.4	80.0	83.3	70.0
Special interest database	83.3	100.0	77.8	70.0	94.4	70.0	72.2	70.0
Electronic mail	93.8	100.0	87.5	100.0	100.0	100.0	93.8	90.0
Balance inquiry	88.9	100.0	55.6	50.0	55.6	50.0	50.0	50.0
Electronic funds transfer	88.2	90.0	64.7	50.0	76.5	60.0	58.8	60.0
General interest database	76.5	100.0	64.7	80.0	88.2	50.0	70.6	70.0
Pay-per-view movies	80.0	100.0	26.7	30.0	20.0	10.0	33.3	20.0
Medical alarm	81.3	90.0	50.0	30.0	37.5	10.0	43.8	30.0
Electronic spreadsheet	68.8	70.0	81.3	100.0	93.8	90.0	87.5	100.0
Color display	30.0	12.5	30.0	0.0	40.0	0.0	20.0	0.0
Speed	66.7	90.0	73.3	70.0	80.0	80.0	73.3	60.0
Graphics	64.7	66.7	76.5	88.9	76.5	55.6	70.6	66.7
User language	71.4	44.4	78.6	77.8	78.6	55.6	85.7	55.6
Alphanumeric keyboard	66.7	60.0	73.3	80.0	93.3	100.0	73.3	60.0
Memory/storage	75.0	80.0	87.5	100.0	81.3	100.0	93.8	100.0
Database management	60.0	70.0	86.7	100.0	93.3	100.0	86.7	100.0

[a]($N_I = 20$; $N_{II} = 12$).

Figures represent percentage of sample selecting each attribute for each service.

[b]Round I [c]Round II

TABLE XXXV. SELECTION TERMINAL DESIGN ATTRIUBES BY ROUND (continued)[a]

Service	Non-Addressable I	Non-Addressable II	No Microprocessor I	No Microprocessor II	Only Numeric I	Only Numeric II	No Memory I	No Memory II
Fire/burglar alarm	5.9	10.0	5.9	20.0	17.6	10.0	35.3	70.0
Video games channel	11.1	10.0	5.6	0.0	22.2	10.0	11.1	0.0
Utility meter reading	6.3	0.0	25.0	30.0	12.5	10.0	43.8	60.0
Utility load management	15.0	0.0	11.8	10.0	15.0	0.0	23.5	30.0
Electronic polling	15.0	10.0	23.5	20.0	58.8	80.0	29.4	50.0
Interactive education	5.6	10.0	5.6	0.0	5.6	20.0	0.0	20.0
Special interest database	5.0	0.0	11.1	20.0	11.1	30.0	11.1	10.0
Electronic mail	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0
Balance inquiry	0.0	0.0	16.7	30.0	50.0	50.0	22.2	20.0
Electronic funds transfer	5.9	10.0	11.8	40.0	29.4	40.0	11.8	20.0
General interest database	11.8	0.0	11.8	10.0	11.8	30.0	5.9	20.0
Pay-per-view movies	13.3	0.0	40.0	40.0	53.3	60.0	40.0	60.0
Medical alarm	12.5	0.0	25.0	20.0	50.0	70.0	31.3	40.0
Electronic spreadsheet	12.5	10.0	6.3	0.0	12.5	10.0	6.3	0.0
Color display	60.0	87.5	60.0	100.0	30.0	25.0	60.0	100.0
Speed	20.0	0.0	13.3	90.0	20.0	10.0	13.3	20.0
Graphics	17.6	11.1	11.8	11.1	23.5	22.2	11.8	22.2
User language	21.4	44.4	14.3	22.2	21.4	33.3	7.1	22.2
Alphanumeric keyboard	13.3	20.0	6.7	0.0	13.3	10.0	6.7	20.0
Memory/storage	6.3	0.0	6.3	0.0	25.0	0.0	0.0	0.0
Database management	20.0	10.0	0.0	0.0	20.0	0.0	0.0	0.0

[a] (N_I = 20; N_{II} = 12).

Figures represent percentage of sample selecting each attribute for each serivce.

specifying precise engineering, economic and other practical constraints might be enumerated. These criteria might then be systematically applied in a laborious process of evaluating each technology. Ultimately, this laborious alternative may be unavoidable in a formal cost benefit analysis, especially if certain specific innovation patterns of industrial innovation are followed.[15]

In the near term, decisions regarding the design and diffusion of technologies must be made. These decisions need to be based on some kind of informational input. Information can range from the totally subjective to the toally objective, as considered above. Using a Delphi procedure to collect information may offer a compromise between these endpoints of the continuum. Assuming group data are better than individual estimates, as an advocate of the theory of errors might argue, the Delphi method can contribute something to this decision-making process.

As noted earlier in the chapter, there are some group estimates which do not appear to be quite on the mark. There are several possible explanations for this phenomenon. First, the group simply may be wrong in their estimate. For example, there is no apparent reason to expect that the telephone should not be an appropriate choice for the delivery of color signals and graphics, especially in light of the Prestel experience.

Another explanation is that perhaps the group has identified a complex issue with competing but equally valid solutions that is inadequately measured by the instrument. One might seize upon this type of counter-intuitive finding in future research. This is one of the benefits of the group estimation process and the Delphi method in

general, discovering things that the researcher as an individual might not have considered.

An additional possiblity is that this particular study has produced somewhat invalid data due to faulty instrumentation. Given the informal feedback from the group, this seems to be a fairly likely reason for some of the apparent discrepancies observed in the data. The questionnaire might have been too long, demanding or ambiguous. The description of each item was accomplished as succinctly as possible but perhaps optimal wording had not been achieved. It did appear from informal comments, that the overall task was understood and that respondents found the general nature of the research to be of interest to them.

The items may not have been independent of one another. In other words, factors such as item ordering and fatigue effects may have some bearing on the final data. Each respondent was asked to make approximately two-hundred sometimes quite involved judgements. In future studies, the items might be placed in a random order on each questionnaire to partially overcome this type of effect.

Apart from several estimates which may lack validity or correspondence with verifiable data, the study was generally successful. These findings should not be taken as conclusive, but as indicative of general directions. It is quite clear that two-way cable systems and the telphone are the most promising technologies for the implementation of most of the services studied. Other technologies are able to provide subsets of services. To the extent that these other technologies offer cheaper alternatives to two-way cable and telephone systems, these may be adopted by consumers. Since each of the

technologies other than two-way cable and telephone support only a subset of the services, it would appear likely that consumers would adopt more than one of these technologies to attain the full complement of services most relevant to their own self-perceived communication needs.

CHAPTER VI

Reference Notes

[1]See for example, Wicklein, John W., "Wired City, USA," The Atlantic, February 1979, pp. 35-42.

[2]Rogers, Everett M., Diffusion of Innovations, (New York: Free Press, 1983), p. 232.

[3]"Cable Interconnects: Making Big Ones Out of Little Ones," Broadcasting, March 1, 1982, pp. 59-62. This constraint is due to the fact that cable systems must seek franchise agreements which usually are awarded by local governments. See: Baldwin, Thomas F. and D. Stevens McVoy, Cable Communications, (Englewood Cliffs, NJ: Prentice-Hall, 1983), pp. 188-236.

[4]Baldwin and McVoy.

[5]Graf, Rudolf F., Modern Dictionary of Electronics, (Indianapolis, IN: Howard W. Sams & Co., Inc., 1977, p. 91).

[6]Prior to the Supreme Court's ruling in FCC v Midwest Video (440 US689, 1979), the FCC required most cable systems to be capable of becoming interactive. For systems to become activated for two-way communication, upstream amplifiers would need to be added.

[7]Baldwin and McVoy, p. 57.

[8]The reader will note that the FCC reallocation of a portion of the TV spectrum comprising UHF channels 70-83 from the broadcasting service to the land mobile service in 1970. (FCC Docket No. 18262, FCC 70-519, May 20, 1970.)

[9]Federal Communications Commission, Proposed Rule, "Proposed Authorization of Transmission Teletext by TV Stations," BC Docket No. 81-741, Federal Register, December 14, 1981, pp. 60851-60859.

[10]For a full discussion of teletext applications, See: Tydeman, John et al., Teletext and Videotex in the U.S., (New York: McGraw-Hill, 1982).

[11]See for example: "FCC Authorizes Use of AM Carriers for AM Stations," Communications News, July 1982, p. 18; FCC, Notice of Proposed Rulemaking, "Use of the Subsidiary Communications Aurhorization for Utility Load Management," BC Docket No. 81-352, Federal Register, May 21, 1981, pp. 6-15.

[12]Sigel, Effren (ed.), Videotext: The Coming Revolution in Home/Office Information Retrieval, (White Plains, NY: Knowledge Industry Publications, 1980).

[13]Dassler, A. Fred, "What Are They Doing to Direct Broadcast Satellite Services?" Telecommunications, November 1981, pp. 29-32. An argument for using systems with larger service areas is presented in: Harley W. Radin, "More is Not Better: The Case for Three DBS Service Areas," Satellite Communications, August 1982, pp. 32-36.

[14]Holsendolph, Ernest, "Here Comes Low Power TV," New York Times, April 11, 1982, p. 6F.

[15]Abernathy, William J. and Sames M. Utterback, "Patterns of Industrial Innovation," Technology Review, June/July, 1980.

CHAPTER VII

SUMMARY AND DISCUSSION

This research seems to offer four contributions to an understanding of the adoption of telecommunication innovations and their application to communication needs. First, some diagnostic methods and tools have been developed. These methods serve to relate communication needs to telecommunication products and services. Second, the usefulness of considering both the tangible and intangible attributes of telecommunication innovations has received support. Third, there appears to be some correspondence between present attitudes and past adoption behaviors. This correspondence may support an argument that there is some validity in using present attitudes to predict future adoption behaviors. Finally, some useful experience was gained in conducting the Delphi study. In this chapter, these contributions are further considered. In addition, new directions for this type of research are considered. These suggestions are based on the findings and experiences contained in this report.

Diagnostic methods and reinvention

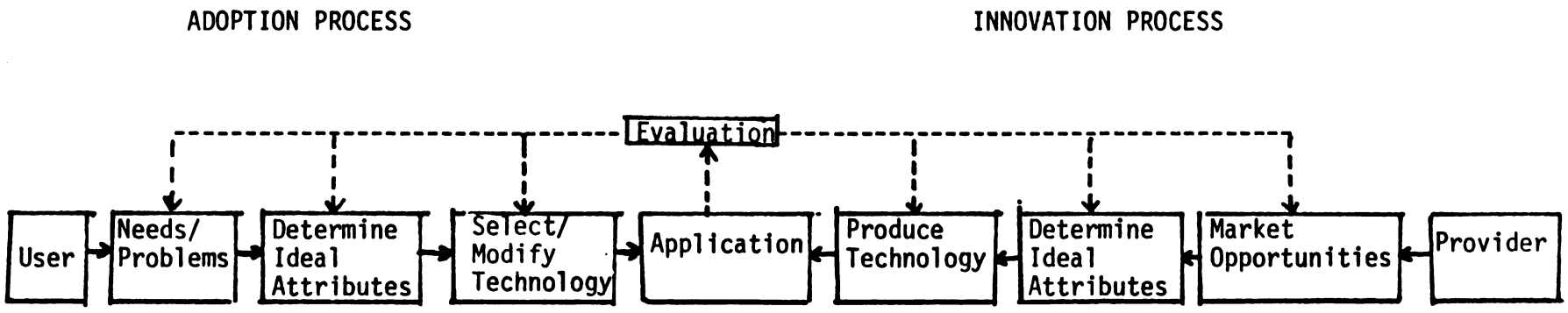
The limitations of innovation research which focused only on the process culminating in the adoption decision has concerned researchers. Beginning in the 1970's, the subsequent process of implementation or application of adopted innovations began to interest social scientists.

The most successful innovations were those which performed well in applied settings, in terms of user needs and demands. Innovation providers or producers were, therefore, concerned with their ability to design and package innovations capable of responding to these needs and demands. Adopters were concerned with their ability to apply innovations to their particular set of circumstances. Typically, the effectiveness of innovations in meeting needs was enhanced through some type of adaption or modification either by the adopters or by the innovation producers. It became important to find predictive and descriptive methods for diagnosing the ability of innovations to meet needs in applied settings. In other words, the innovation process was considered to extend beyond the adoption decision to include an implementation phase.

The amount of interest in developing diagnostic methods to assess the extent to which innovations were capable of adequately serving user needs in the implementation or application stage stimulated further work in this area. These diagnostic methods, once developed, could be useful both in the initial design phase as well as in later stages of the product life cycle.[1] It was observed by researchers that innovations are not adopted into static environments. Social scientists realized that adopters were not just passive accepters of innovations. Instead, adopters came to be considered as active in terms of (1) modifying and adapting innovations; or (2) demanding changes made by the innovation provider.

The implementation phase is thus dynamic from either or perhaps both the adopter's and provider's perspectives. These two perspectives are modeled in Figure 2.[2] This model is an extension of the model first

FIGURE 2. MODEL OF THE INNOVATION/ADOPTION PROCESS



presented in Figure 1 (Chapter 2). These processes are dynamic in the sense that the adoption and innovation processes are seen to incorporporate feedback from the application and evalution stages. Based upon these results, the appropriateness of an innovation for serving a given set of needs are judged. This experience may lead to modifications in the previous inputs to the model. Essentially, Figure 2 depicts an iterative and heuristic process which can loop until both the adopter and the innovation provider are satisfied that needs and hence market opportunities are adequately addressed.

Rogers uses the term, "re-invention," to label the process of applying an innovation to serve needs; evaluating this experience and subsequently seeking to modify an adopted innovation to better serve needs.[3] In the extreme case, modification may be insufficient and the innovation may be rejected. For example, the consumer who buys a home computer with only a vague notion of what is needed to operate it or what it can do. Eventually, it may turn out that the computer has insufficient processing power to storage to handle tasks expected of it, or the user may find it too difficult to program. In this case, the computer may not be used at all or it may be used in some fashion which differs from its originally intended implementation.

There is evidence that as the complexity of innovations increases, so does the tendency for reinvention.[4] This tendency increases when the adopter does not have a very rich understanding of the details of the innovation.[5] Innovations with attributes suited to serving a wide variety of needs are likely to be reinvented.[6] The manner in which the attributes of the innovation are collected or bundled, also affects the reinvention process. Tightly bundled innovations, with highly

interdependent components which must be adopted on an "all or none" basis are much more difficult to reinvent or modify than more loosely bundled innovations.[7] As a consequence of being tightly bundled, these innovations are less likely to perform satisfactorily in the implementation stage and are more susceptible to subsequent rejection.

The degree to which reinvention occurs seems also to be a function of the types of needs adopters may have. Narrowly defined needs might be associated with less reinvention of adopted innovations. Adopters who define their needs narrowly may seek single application innovations. Adopters who define their needs more broadly may seek general purpose applications. This classification of adopter-type may be important in predicting the success of innovations.

As argued earlier in this report, telecommunication innovations may be somewhat unique because of their effect on our most characteristic behavior, communication. The reinvention process seems especially inevitable with telecommunication innovations because these technologies can be applied to such a wide set of needs. In addition, telecommunication innovations such as those studied here, can be loosely bundled. This permits the adopter the freedom to select from a range of options in services and features, those which are most suited to their individual needs.

In a field study using telephone and two-way cable technologies to provide videotext services to home consumers, it was discovered that most subscribers wanted a smorgasbord of services that will keep them informed; save time and money; and entertain them. These results are consistent with the findings in the present study. Interestingly, this same study also determined that videotex technologies were perceived by

adopters as a "comprehensive home information service," and not just an "electronic newspaper." This finding supports a major premise of the present study, namely that innovations such as videotex are perceived in terms of attributes (e.g. various information services) and not as an intact, indivisible product (e.g. "electronic newspaper").[8] An intact, indivisible product is by definition, tightly bundled.

Innovation research is a rich areain the literature with studies numbering in the thousands. The adoption process is becoming fairly well understood by researchers. The remainder of the innovation process, which includes the application, evaluation and modification stages (e.g. reinvention) are less well understood. The reinvention stage involves the matching of innovation attributes to needs on an applied and experimental level. Based upon their experiences, adopters may seek to modify (reinvent) an innovation. Either they will attempt to modify the innovation themselves or demand changes be made by the innovation provider who will be looking for market opportunities. Alternatively, adopters may simply reject an innovation as hopelessly inappropriate and perhaps seek an entirely different innovation perceived to be better suited to their needs.

The importance of understanding the needs of potential adopters and how these needs relate to the attributes of innovations seems clear, not only in terms of the original adoption decision, but also in terms of the reinvention process. The ability to diagnose the potential or actual effectiveness of innovations is contingent upon an understanding of how needs and attributes relate. This is the issue to which much of the present research was addressed.

This study sought to maintain generalizability by considering broad based communication needs and unbundled innovation attributes. The nature and salience of the needs and attributes were farily well established in the research literature. While it is important to study these established needs, undoubtedly new needs will emerge in the context of these sophisticated computer-based telecommunication technologies. Research designs should be sensitive to these previously unmeasured needs. If one were to conduct a needs assessment and functional analysis of computer-based telecommunication innovations, perhaps two specific constructs might prove useful to this end.

The first construct to consider is that of "functional displacement." Assuming that the potential adopter is cognizant of a set of needs and a set of non-innovative alternatives for satisfying these needs, one or more of these alternatives should be selected. These needs may then be: (1) adequately served; (2) underserved; or (3) unserved, given the properties and limitations of the alternative(s) selected. To the extent that present alternatives leave needs underserved or unserved, innovations may appear progressively attractive to potential adopters. If innovations can perform functions similar to the present methods used more efficiently, then these innovations may be adopted and displace the functions of the previous technology.

For example, to handle banking in a convenient manner, people may choose an automatic teller machine rather than a live teller for conducting transactions. This technology has attributes which permit greater flexibility in terms of geographic access and time scheduling. However, even the automatic teller machine technology may be displaced by a service which permits banking to be conducted electronically from the home.

The other construct which may be worthwhile to consider is "functional placement." This would relate primarily to unserved needs but may also be appropriate for considering underserved needs. In this case, the potential adopter is seen to be relatively unaware of a need. Actually, a set of needs may not even exist until after the adoption of an innovation. In other words, the need for new functions is somehow placed into the adopter's personal needs agenda as a consequence of adopting an innovation.

Functional placement is an outcome of the reinvention process. Once a technology is made available to adopters, the innovation may be applied to serve needs not previously considered. For example, a home computer may be purchased initially forits entertainment applications. After adoption, the symbol processing and storage power of the machine may become evident to the adopter. At this point, the adopter may entertain consideration of new uses such as creating and maintaining electronic databases (mailing lists; household inventories or tax records are examples of this).

Perhaps the need to keep timely and organized household records was perceived to be adequately served until the user became aware of the computer's potential. Once aware of a superior alternative, an alternative which offered greater accuracy, capacity and convenience, the adopter might reevaluate their present situation and decide that their need for good records was in fact unserved (or underserved). Whereas "record-keeping" may have meant cardboard boxes stuffed with receipts tucked away in a closet, after witnessing the power of a computer, the placement of a need for a highly organized and accessible database may occur. Naturally, this need corresponds nicely with what the computer

has to offer. In fact, this may be another problem. Adopters may prematurely limit the range of potential alternatives considered to serve needs by defining their needs only in the context of immediately available innovations.

Future research should consider not only the relatively broad based needs included in this study, but should go on to consider needs which are more narrowly defined. In this sense, "narrowly defined" is meant to indicate operationalizations of "needs" which are appropriate to a consideration of the attributes of computer-based telecommunication technologies. A start in this direction was attempted in this study. Issues of functional displacement or placement should be considered, especially in the reinvention process. Diagnostic methods and tools should be refined to enhance the ability to predict functional displacement or placement applications of adoptions. Such methods and tools might include survey and field studies in applied settings using interviewer or respondent administered instrumentation as well as exposing adopters to actual innovation prototypes.

Functional displacement can perhaps best be operationalized as the tendency to shift present activities away from one mode and toward another. Banking is a common activity. One might displace the mode of banking from personal visits to the bank, to using automatic teller machines to using a home banking service. In each case, the same need was being served. More importantly, this need existed prior to the adoption of successive innovations.

On the other hand, functional placement can be operationalized as the tendency to initiate new activities as the result of innovation adoption. Household record keeping may have consisted of storing things

haphazardly in cardboard boxes in a closet. But the introduction of a personal computer to the home environment may stimulate a need to create and maintain a new record keeping structure which capitalizes on the computer's database management capabilities.

Future research designs should consider functional displacement and placement constructs. Needs assessments and the relationships between needs and attributes appear to be central to an understanding of how innovations are implemented in the post adoption phase. A diagnosis of processes in this stage can lead to better adoption decisions by enabling better predictions to be made regarding which innovation may be the best choice, given particular needs. This will also permit better design and marketing decisions to be made by innovation providers.

Tangible and intangible attributes

In the previous section, the utility of considering the relationship between communication needs and innovation attributes was discussed. These attributes can be considered further in terms of their tangible or intangible nature. Tangible attributes are those functions of an innovation, such as its services and features, which can be objectively determined. Intangible attributes are more subjectively determined. For example, a home banking service may enable a variety of reliable and accurate transactions. This can be objectively assessed. The extent to which this technology is perceived to be computerized and how potential adopters feel about computerization is a more subjective issue and, thus, an intangible attribute.

Given the case where there appears to be a nearly perfect correspondence between needs and tangible attributes, but no adoption, there

would apparently be some kind of alternative explanation. Naturally, a number of situational or demographic variables might explain this. But even holding these variables constant, the issue may not disappear. A home computer may apparently be the perfect solution to word processing needs and yet not be adopted. The explanation could be that the potential adopter has negative attitudes towards computers in general. Perhaps the person feels intimidated, embarrassed or otherwise threatened by computers. Research findings support this possibility. The origins of these attitudes are typically not experientially based. A hands on trial providing direct experience with the technology may reduce some of the negative attitudes towards computers.[9]

Understanding how people generally feel about things such as computers; convenience; saving money and social interaction may enhance the ability to predict adoption of innovations which may affect these aspects of peoples' lives. Strong relationships were found in this study between intangible and tangible attributes of innovations. Intangible attributes, such as those considered in this study should be operationalized in terms fairly specific to the tangible attributes considered to render the best adoption predictions. Attitudes which are more situation specific tend to be better predictors of subsequent behaviors (e.g. adoption) than more generalized attitudinal measures.[10]

Intangible attributes are especially important to consider in telecommunication innovations. As cost and convenience become more important, people may begin to choose telecommunication alternatives for things such as banking, shopping, or information retrieval, rather than going to the bank, store or newstand. This may adversely affect other needs which were coincidentally served in the former way of

meeting these needs. Going out to the newsstand may not only accomplish getting a newspaper, it may also be an excuse to get out of the house, meet people or walk a dog.

Present attitudes and future adoption

As noted in the previous section, research findings indicate that the more situation specific the attitudinal measures are, the better the ability for predicting subsequent behaviors. The best way to test the relationship between present attitudes regarding "pre-purchase preferences" or the salience of innovation attributes and actual adoption decisions is to use logitudinal designs capable of empirically linking these domains.

An alternative to longitudinal designs which are expensive and time-consuming, is to use cross-sectional desings such as the present study. The validity of cross-sectional findings may be more suspect than findings from longitudinal research. However, cross-sectional research may be a wiser choice for the beginning stages of a research program. If one is to have confidence in the ability of cross-sectional attitudinal measures to predict future behaviors, then certainly these measures ought to be able to explain a significant amount of variance in similar past behaviors.

Some support for this expectation was obtained in the present study. A flaw was noted in the design. The behavioral measure used in this study was household adoption of innovative and non-innovative telecommunication related products and services. The attitudinal measures were operationalized at the individual level. Thus, a potential source of extraneous variance was not controlled. An alternative explanation

for the mixed findings is that the individual interviewed was not necessarily influential in making household purchasing decisions. Regardless of their attitudes, in this case they would have little or no impact on household adoption behaviors.

Future research should operationalize the attitudinal and behavioral measures using comparable units of analysis. The selction of the household as the unit of analysis while somehow weighting the importance of individuals in the household decision-making process is probably the most valid and, therefore, promising avenue to pursue.

Delphi technique

A person who was reasonably well informed on the basic limitations and capabilities of the telecommunication technologies considered in this study could probably do an acceptable job of estimating the relationship between the attributes and technologies spaces considered in Figure 1 (Chapter II). However, depending upon the nature of the task, groups are found to produce superior results for intellectual tasks[11] although the time to solution may be greater than for individuals.[12] This was one reason for selecting the Delphi technique in the second study reported here. The other reason was that the nature of the task was such that it seemed more efficient to measure subjective judgements rather than to seek more objective measures and avoid human judgement altogether.

Generally, the Delphi technique seemed to produce reasonable outputs. A few anamolies are apparent in the data. Future research might try to reduce the magnitude of the task expected of the respondents and perhaps provide more direction as to exactly what is expected. If a

complex and comprehensive instrument is somewhat unavoidable, it may be helpful in terms of reducing respondent fatigue, to divide the participants into subgroups and then subdivide the task for assignment to subgroups.

Integrating major findings of Consumer and Delphi studies

The results of the consumer study reveal several things about the process by which computer-based telecommunication technologies are adopted and applied by consumers to serve their needs. First, it is clear that communication needs are related to the salience of various attributes of these technologies (see Tables XIV-XV). In particular, the need to have a degree of flexibility in managing one's time (e.g. time elasticity) is a useful predictor of both the number of innovations adopted and the amount one is willing to pay for a package of computer-based services (see Tables XVII-XVIII).

It also appears that the attributes of these technologies are useful predictors of their economic value to consumers. Several factors are prominent. Consumers are concerned with those attributes which provide information transaction and status-monitoring capabilities among other things (see Tables XXII-XXIII). Present telephone usage patterns were useful to some extent in predicting the economic value of newer computer-based services (see Table XXI).

A final major finding of the consumer study was that intangible attributes of technologies affected the perceived salience of various services and features offered (see Table XXIV). From these data one might suspect that an assumption of modal neutrality might not be valid among consumers. In other words, technologies which would appear to

threaten social contact or are perceived as being "computerized" may impress consumers more negatively than other technologies. Loss of social contact and computerization were found to be negatively related to the salience of technological attributes (see Table XXIV).

The point of the Delphi study was to estimate the extent to which a number of different telecommunication technologies could support various computer-based services. The major finding here was that two-way cable television and the telephone were the most appropriate technologies for providing these services (see Tables XXVIII and XXXI). This is very significant since there was a strong relationship between the communication needs variables as a group and the technology attributes variables as a group. A telecommunication technology which can support most or all of the services is likely to be most successful. To the extent that either the telephone or two-way cable television is perceived as less computerized and less of a threat to social interaction, the chances are better that consumers will successfully adopt these technologies for the provision of computer-based telecommunication services. The other telecommunication technologies are able to support these services to a much lesser extent.

Given that two-way cable television or the telephone are the best telecommunication media for providing these services, another question is what type of home terminal to provide. The Delphi study produced a set of estimates which would indicate that most of the services considered in this study would probably require an addressable terminal which is equipped with an on-board microprocessor and local memory and has an alphanumeric keyboard. The addressability is useful for targeting services to specific subscribers. The microprocessor would

permit more sophisticated local (e.g. at home) processing and could make the home terminal more user friendly by adjusting to the user's level of competence. Finally, the alphanumeric keyboard permits full messages using words and other symbols so that textual as well as numeric responses and inquiries can be processed.

Returning to the model depicted in Figure 1, the overall process suggested in this figure is that home consumers develop or become aware of some set of communication needs. Given the awareness of these needs, the consumers seek out attributes or services which will serve these needs. Those technologies which come closest to embodying the preferred set of attributes will do the best job of meeting the demands or needs. Given the present research, the best overall statement that can be made to integrate these two studies is that the set of communication needs which home consumers perceive to be salient are strongly related to a set of computer-based services which can be most appropriately provided via two-way cable television or the telephone. Other telecommunication media choices would be inferior substitutes.

Limitations of this research

In the consumer study several limitations are apparent. First, this was a cross-sectional study which severely limits the ability to infer causation in spite of the statistical models used to test the hypotheses. Strictly speaking no temporal ordering of the variables can be specified although such an ordering has been suggested in the model used in this research (Figure 1).

Another limitation is a validity question. While a goal of this research has been to refine the process of identifying and measuring

variables which contribute to variance in the process of adopting and applying technologies to communication needs, some validity problems must be acknowledged. Describing in just a few words the nature of a computer-based service obviously cannot compare to providing the consumer with actual hands-on experience. Thus, even though the reliability of the measures can be statistically assessed, the more serious concern of validity can only be subjectively estimated.

Another limitation is the implicit assumption in this study that the respondent is influential in determining household adoption patterns. This may not be the case at all. The prevalence of much unexplained variance in the results presented here may be explained by the fact that data collected with the individual as the unit of analysis are used to predict what may be a household decision. This type of "ecological fallacy" can lead to erroneous conclusions.[13] It would probably be a better idea to use the household as a unit of analysis when it does not seem likely that the respondents are the decision-makers. An alternative would be to ask to interview a "household decisionmaker."

In the Delphi study several other limitations can be observed. First, group judgments were seen to be incorrect in some places. For example, broadcast radio was not seen to be capable of providing services such as utility load management or a general database and yet given recent action by the Federal Communications Commission regarding the use of the Subsidiary Communications Authorization (SCA) service, it would appear that broadcast radio is expected to be capable of providing these services.[14]

Given the time and effort consumed in conducting a Delphi study, it might be more efficient for a fairly knowledgeable researcher to make his or her own estimations regarding the appropriateness of various telecommunication media to support computer-based services. Perhaps the errors detected in the group judgment are more related to the relative expertise of the sample and not a reflection of the Delphi method itself. In either case, for purposes of this study it can be seen that the Delphi respondents did identify two-way cable and the telephone as the best telecommunication media for providing a variety of computer-based services. To some extent this may have been a foregone conclusion and the expense and effort of conducting the Delphi study may not have been justified. The Delphi study did serve the purpose of producing an empirical and reliable set of estimates. This method of estimation may be more defensible than a strictly subjective set of estimates from even a knowledgeable single researcher.

Future directions

This type of research is useful for making early warning diagnostics in the beginning stages of a product life cycle.[15] The use of attitudinal research to predict future behaviors, such as the adoption of innovations is problematical. Still, this research can be useful as an exploratory tool. Future research can benefit from the experiences gained here in several ways. First, the household or a household decisionmaker as the unit of analysis seems appropriate. Second, the use of abstract questionnaire items to measure attitudes towards the salience of various attributes should be improved.

Many field studies have been designed to investigate various relationships between consumers and the technologies designed to serve these consumers.[16] These studies which are conducted in laboratory or field settings are providing useful information regarding consumer attitudes towards telecommunication technology after they have been able to experience some of the attributes rather than merely having these attributes verbally described in a survey instrument.

This effort should be continued and some of the findings suggested in this study should be reassessed in the field. For example, will the findings regarding the relationships between communication needs and the salience of technology attributes be replicated in the field? Will new factors emerge in the needs or attributes variables? After having some experience with the products and services, will the perceived economic value change? What is the nature of these attitudes over time--will attitudes be similar at different levels of experience? These and other questions are better suited to laboratory and field research. The initial questions and perhaps some early indication of how the technologies should be constructed can be broached by sample survey research. But to develop more confidence in these findings an attempt to replicate these findings in other research settings is important.

Conclusion

The goal of this research has been to elucidate the inner workings of the adoption and application of computer-based telecommunication technologies. The major thrust evidenced here was to consider the relationship between communication needs and innovation attributes. This seems to present a fruitful manner for a continuing study of

innovations. While this research is cross-sectional, it may be useful for pointing the directions for further exploration using longitudinal designs.

This research represents a starting point for future research and not a culmination. Perhaps more questions are left unanswered than answered at this point. In any case, it seems that as we create innovative ways for serving our communication and information needs, we also create an attendant responsibility to ensure that these innovations are well suited to human as well as technological factors. Innovative telecommunication technologies which are impressive only from an engineering standpoint and not from an applied human perspective may leave us no better off and perhaps worse off than we were before. The ability to diagnose mismatches between technologies and needs before they happen or perhaps as they happen can help us to build better machines which serve to enhance our abilities to communicate and manage information.

CHAPTER VII

Reference Notes

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APPENDIX A

APPENDIX A

TELEPHONE SURVEY INSTRUMENT FOR CONSUMER STUDY

INNOVATION STUDY
TC 335 SUMMER 1982
DUCEY 355-7563

TEL. NO. (_____) COLS

I.D. No. (_____) 1-3

FINAL STATUS OF INTERVIEW (1) COMPLETE (2) INCOMPLETE (3) REFUSAL
(4) DISCONNECT (5) JUNK (6) OTHER:_____

Call #	INTERVIEWER NAME	DATE	TIME	RESULT (BZ/NA/CB)
1	_____	____	____	_____
2	_____	____	____	_____
3	_____	____	____	_____
4	_____	____	____	_____

BZ=BUSY
NA=NO ANSWER
CB=CALL BACK

INTRODUCTION: "Hello, I'm _____ calling from Michigan State University. We're doing a study in the East Lansing area on new kinds of media, such as two-way cable television and home computers and I have a few questions I'd like to ask a male/female over 18 at this number."

1. First, do you live within the city limits of East Lansing?

   (1) YES (2) NO (TERMINATE)

2. How many working television sets are in your household? (_____) 0-9+ 4

   (IF ZERO, GO TO Q.4) (IF NOT ZERO, ASK:)

   2a. How many of these are color sets? (_____) 0-9+ 5

3. Does your household subscribe to cable television?

   (1) YES (2) NO (9) DK/REFUSED 6

   (IF NOT GO TO Q.4) (IF YES, ASK:)

   3a. Does your household also subscribe to any of the pay movie services such as Home Box Office, The Movie Channel, Cinemax or Escapade?

   (1) YES (2) NO (9) DK/REFUSED 7

   3b. If YES, ASK:

   Which services do your household subscribe to?

   (_____) NUMBER 8

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SUMMER 1982
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4. I would like to know how you feel about several different things. Please tell me whether you strongly agree, agree, feel neutral, disagree or strong disagree with each of the following statements:

		SA	A	N	DA	SDA	
a.	It is very inconvenient to go out of the house on shopping trips.	5	4	3	2	1	9
b.	It is very inconvenient to go out of the house on trips to the bank.	5	4	3	2	1	10
c.	If I could do things like shopping and banking without leaving home, I would miss seeing and talking to people I normally meet on these trips.	5	4	3	2	1	11
d.	I often try new products or services before my friends or neighbors do.	5	4	3	2	1	12
e.	Society is becoming too dependent on computers.	5	4	3	2	1	13
f.	Computerized records are a threat to my privacy.	5	4	3	2	1	14

5. Now I have some questions about different needs people sometimes say they have. Please tell me how important each need is to you by telling me whether it is very important, important, not very important or not important at all.

		VI	I	NVI	NIAA	
a.	The need to keep up with current events.	4	3	2	1	15
b.	The need to obtain useful information for daily life.	4	3	2	1	16
c.	The need to keep up with the way government does its job.	4	3	2	1	17
d.	The need to take less time to run errands out of the house.	4	3	2	1	18
e.	The need to relax and reduce tension.	4	3	2	1	19
f.	The need to understand what goes on in the U.S. and world.	4	3	2	1	20
g.	The need to be entertained.	4	3	2	1	21
h.	The need to kill time.	4	3	2	1	22
i.	The need to improve myself.	4	3	2	1	23
j.	The need to take less time with household bookkeeping.	4	3	2	1	24
k.	The need to spend time talking with friends and relatives.	4	3	2	1	25
l.	The need to have news, sports, weather and other types of current information available when it fits my schedule.	4	3	2	1	26

Appendix A

INNOVATION STUDY
SUMMER 1982
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COLS

5. (cont)

	VI	I	NVI	NIAA	COLS
m. The need to keep records on household finances organized and up to date.	4	3	2	1	27
n. The need to have the television programs I like available when it fits my personal schedule.	4	3	2	1	28
o. The need to cut down transportation costs by not going out of the house as often.	4	3	2	1	29

6. Now I have a few questions about different kinds of things you might do. Please tell me whether you do each thing I mention very frequently, frequently, not very frequently or never:

	VF	F	NVF	N	
a. How often do you go to a library?	4	3	2	1	30
b. How often do you use automatic bank tellers, machines where you insert a plastic card and enter a password to make a transaction?	4	3	2	1	31
c. How often do you buy things over the telephone?	4	3	2	1	32
d. How often do you ask for prices of things over the phone?	4	3	2	1	33
e. How often do you buy things through the mail?	4	3	2	1	34

7. Okay, I'd like to ask you a few questions about how much time you spent yesterday using different kinds of media.

	COLS
a. How long did you watch television yesterday? (_____) MINUTES	35-37
b. How long did you listen to radio yesterday? (_____) MINUTES	38-40
c. How long did you spend reading newspapers yesterday? (_____)MINUTES	41-43
d. How many personal, non-business telephone calls did you make yesterday? (_____) EXACT NUMBER	44-45
e. How many personal letters did you write last month? (_____) NUMBER	46-47

8. There are a variety of new computer-based services which could become available to people like yourself. These services make use of either a computer in your home or connect you to a computer by using telephone lines or cable television lines. I would like to know how important these services are to you. For each service I mention, please tell me whether it is very important, important, not very important or not important at all.

	VI	I	NVI	NIAA	COLS
a. How important is a service that would connect a computer to your home to provide automatic fire and burglar alarms?	4	3	2	1	48
b. How about a service which would let you play different kinds of video games from your home?	4	3	2	1	49

Appendix A

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SUMMER 1982
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		VI	I	NVI	NIAA	COLS
8.	(cont)					
	c. How about a service that would connect a computer to your home to automatically read your utility meters?	4	3	2	1	50
	d. How about a service that would connect a computer to your home to automatically turn down the hot water heater and the heat or air-conditioning in your house when they are not needed, in order to save money?	4	3	2	1	51
	e. How about a service that would let you vote from home in local elections or opinion polls?	4	3	2	1	52
	f. How important is a service that would let you take school courses for college credit, if you wish, where you could ask questions or send answers automatically from your home?	4	3	2	1	53
	g. How about a service that would let you get special interest information which could be shown as words and pictures on your television screen? This is the kind of information you might normally get by going to the library.	4	3	2	1	54
	h. How important is a service that would let you send or read messages to other people which could be shown on your television set instead of using paper? Some people call this electronic mail since it is like the regular mail service in some ways.	4	3	2	1	55
	i. How about a service that would let you do things like find out the balance of your bank accounts?	4	3	2	1	56
	j. How about a service that would let you pay bills automatically from your house?	4	3	2	1	57
	k. How about a service that would let you get general interest information which could be shown as words and pictures on your television set? This would be the kind of information you could usually get by going to a newsstand, for example.	4	3	2	1	58
	l. How about a pay-per-view movie service that would let you pay only for those movies that you actually watched, rather than paying a flat rate?	4	3	2	1	59
	m. How about a service which would let you automatically signal a medical emergency in your home?	4	3	2	1	60
	n. How important is a service which would help you do math problems like keeping track of household finances, doing taxes, or doing homework?	4	3	2	1	61

9. How much per month would you be willing to pay for a package of those computer-based services which are most important to you? Would you be willing to pay:

(1) Less than $5 per month, (2) $5-10 per month,

(3) $11-20 per month, or (4) more than $20 per month? 62

Appendix A

INNOVATION STUDY
SUMMER 1982
PAGE 5

COLS

10. These services we have just talked about can be provided in slightly different ways. To help us understand your preferences, please tell me how important each of these features are. Please tell me whether each feature is very important, important, not very important or not important at all.

	VI	I	NVI	NIAA	COLS
a. How important is it for you to have all of the words and pictures be shown in color on your television set?	4	3	2	1	63
b. How important is it for you to get information immediately after you decide you want it?	4	3	2	1	64
c. How important are pictures such as graphs or charts to help you understand results from math problems?	4	3	2	1	65
d. How important is it for you to be able to use these services and not have to learn a computer language like BASIC or FORTRAN?	4	3	2	1	66
e. How important is it for you to have a typewriter-like keyboard which would let you type full messages instead of simple yes/no responses?	4	3	2	1	67
f. How important is it to be able to keep all of your household bookkeeping in a computer and not have to save all of the paper records?	4	3	2	1	68
g. How important is it to have a useful way to index your bookkeeping records so you can get the information you want more easily?	4	3	2	1	69

For the purposes of this study, it is important for us to know what kinds of things you presently have available in your home.

11. How many working radios do you have in your home? (_____) 0-9+ 70

12. How many operating telephones do you have in your home? (_____) 0-9+ 71

13. How many of these telephones have push-buttons instead of rotary dials? (_____) 0-9+ 72

14. How many of these telephones did you buy from somewhere other than the telephone company? (_____) 0-9+ 73

15. Do you have a videocassette recorder in your home?

(1) YES (2) NO (9) DK/REFUSED 74

IF YES:

15a. How long have you had this videocassette recorder? (____) MONTHS 75-77

15b. How many pre-recorded videocassettes do you have? (____) NUMBER 78-80

Appendix A

COLS

16. Do you have a videodisc player in your home?

(1) YES (2) NO (9) DK/REFUSED 81

IF YES:

16a. How long have you had this videodisc player? (_____) MONTHS 82-84

16b. How many videodiscs do you have? (_____) NUMBER 85-87

17. Do you have an audio tape recorder in your home?

(1) YES (2) NO (9) DK/REFUSED 88

18. Do you have a video game machine, like Atari, Intellivision or Odyssey?

(1) YES (2) NO (9) DK/REFUSED 89

IF YES:

18a. How long have you had this video game? (_____) MONTHS 90-92

18b. How many game cartridges do you have? (_____) NUMBER 93-95

19. Do you have a home computer like the Radio Shack TRS-80 or Apple?

(1) YES (2) NO (9) DK/REFUSED 96

IF NO:

19a. Have you ever used a computer at work, school or somewhere else?
(1) YES (2) NO (9) DK/REFUSED 97

IF YES:

19b. How long have you had this home computer? (_____) MONTHS 98-100

19c. How much did you pay for this home computer? (_____) DOLLARS 101-104

19d. How much have you spent on buying Software? (_____) DOLLARS 105-108

19e. How many pre-written programs do you have? (_____) NUMBER 109-111

19f. Do you write programs yourself? (1) YES (2) NO (9) DK/REFUSED 112

19g. What are the major ways your computer is used in your household?

_____

_____ 113-114

_____(EXACT RESPONSE)

19h. Who uses the computer most? (1) SELF (2) CHILDREN (3) SPOUSE
(4) BROTHERS/SISTERS (5) PARENTS (6) OTHER:_____ 115

Appendix A

INNOVATION STUDY
SUMMER 1982
PAGE 7

COLS

20. Do you have a stereo system in your home?

(1) YES (2) NO (9) DK/REFUSED 116

21. Does your household subscribe to any of the long distance telephone services which offer cheaper rates than regular Bell Telephone service, such as MCI, Sprint or ITT? (CHECK ALL THAT APPLY)

(1) YES (2) NO (9) DK/REFUSED 117

IF YES:

21a. Which service or services do you subscribe to:

(1) MCI (2) ITT (3) SPRINT (4) OTHER _____

(9) DK/REFUSED 118

22. Do you have a Citizen's Band or CB radio in your home or car?

(1) YES (2) NO (9) DK/REFUSED 119

IF YES:

22a. How many channels can it receive? (_____) NUMBER 120

22b. How long have you had this CB radio? (_____) MONTHS 121-123

23. Do you have a set of encyclopedias in your home?

(1) YES (2) NO (9) DK/REFUSED 124

24. Is there an intercom system in your home?

(1) YES (2) NO (9) DK/REFUSED 125

I have just a few final questions.....

25. Would you please tell me your age? (_____) YEARS 126-127

26. Are you married? (1) YES (2) NO (9) REFUSED 128

27. Are there children under 12 living in your household?

(1) YES (2) NO (9) REFUSED 129

IF YES:

27a. How many children under 12 are living in your household? (____) NUMBER 130-131

28. Counting yourself, how many people live in your household? (_____) NUMBER 132-133

29. How long have you lived in the East Lansing area? (_____) YEARS 134-135

Appendix A

COLS

30. How much education have you completed?

(1) 8TH OR LESS
(2) 9TH-12TH
(3) HIGH SCHOOL GRADUATE
(4) SOME COLLEGE
(5) COLLEGE DEGREE
(6) GRADUATE WORK
(7) GRADUATE DEGREE
(9) REFUSED

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31. And finally, is your total annual household income more than $15,000?

(--) YES (GO TO Q.31a) (1) NO

31a. Is it more than $25,000?

(--) YES (GO TO Q.31b) (2) NO

31b. Is it more than $35,000?

(--) YES (GO TO Q.31c) (3) NO

31c. And finally, is it more than $45,000?

(5) YES (4) NO (9) DK/REFUSED

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Thank you very much for your help in conducting this survey.

RECORD SEX BEFORE MOVING ON TO NEXT QUESTIONNAIRE:

32. SEX: (1) MALE (2) FEMALE

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APPENDIX B

APPENDIX B

INSTRUMENTATION FOR DELPHI STUDY - WAVE I

MICHIGAN STATE UNIVERSITY

COLLEGE OF COMMUNICATION ARTS AND SCIENCES
PH.D. PROGRAM IN THE MASS MEDIA

EAST LANSING · MICHIGAN · 48824

August 12, 1982

Dear Fellow HCT Member:

I would like to ask for your assistance in conducting a Delphi-type research study on telecommunication technology. As a member of the Human Communication Technology Interest Group of the International Communication Association, you have already indicated an interest and perhaps special knowledge in this area. This research is in connection with my Ph.D. dissertation and is not officially related to any HCT Interest Group function.

One recent example of a Delphi study is Joseph N. Pelton's, "The Future of Telecommunication: A Delphi Survey," Winter 1981 issue of the Journal of Communication, pp. 177-189. Essentially, the purpose of a Delphi survey is to create a structure for a group communication process. The end result of this survey is a collection of best estimates regarding some set of phenomena. This result is achieved by asking an expert group to make an initial set of judgements or estimations. These data are tabulated and sent back to the group members. After examining the distribution of group responses, an opportunity is provided to re-estimate initial estimations. The procedure is repeated until some stability has been achieved. Typically, two or three rounds are sufficient.

The purpose of this study is to develop estimates on the extent to which various telecommunication technologies can provide a number of teleservices. A system to provide teleservices would include a telecommunication link, a terminal device and a computer system. In this study the concern is with the telecommunication link and the terminal device. The home television receiver is assumed to be an appropriate display device. The computer systems used to provide these services can be very complicated and better treated as a separate subject.

The structure of the questionnaire suggests two major system components required to provide these computer-based telecommunication services to home consumers: (1) a telecommunication link and (2) some type of terminal device is required in the home. I am asking you to make judgements on what type of terminal is most appropriate for each service. Simple categories of terminals are used. Also, I would like you to rate the extent to which each telecommunication technology can be used to support each service. Please mark in the appropriate cell, the codes corresponding to the most appropriate terminal device, and the extent to which each telecommunication technology is an appropriate medium for each service. In responding to these items, feel free to

consider new uses of the technologies, such as devoting an entire video channel to data communication, or using the available portions of TV and radio signals to transmit data, as in teletext.

I have enclosed a self addressed return envelope. Please use this to send the questionnaire back to me. I would appreciate it if you could respond as soon as your schedule permits. Hopefully this will be within one week of the time you receive this. Since at least two and possibly three rounds may be required, the sooner each round is completed, the better. Your responses will remain anonymous.

I want to sincerely thank you for assisting me with my dissertation research. I am very pleased to have this opportunity to work with you all. If things go well, perhaps I will have an opportunity to present some of my findings at next year's meeting of the ICA and HCT in Dallas.

Thank you again for your interest and cooperation.

With best regards,

Richard V. Ducey

P.S. If you have any questions, I can be reached at (517) 353-6410 or 355-8372.

RVD:aia

Enclosure

Appendix B

HCT Delphi Survey
August 1982
Round One

DIRECTIONS: This questionnaire is divided into several sections. The first section provides a few key word descriptors of each technology in terms of (1) geographical service area, (2) bandwidth, (3) one-way vs. two-way and (4) type of communication voice, video, data. In this section you are asked to rate your own technical knowledge with respect to the technologies. In the next section you are asked to estimate the extent to which each telecommunication technology can support each service, and which type of terminal is most appropriate for each service. Finally, some demographic questions are asked to assist in the analysis of these data.

I. Self Rating on Technologies: For each technology described, please rate your technical knowledge on a seven point scale where 7 = very knowledgeable and 1=very unknowledgeable about this technology.

		Not Knowledgeable						Knowledgeable
A.	ONE-WAY CABLE TV (limited service area--one or two towns; broadband; one-way only; voice, video and data)	1	2	3	4	5	6	7
B.	TWO-WAY CABLE TV (same as above, but data communication can be returned from the home, making it two-way)	1	2	3	4	5	6	7
C.	BROADCAST TV (UHF or VHF) (metro size service area; 6 MHz; one-way; voice, video, data, one-way)	1	2	3	4	5	6	7
D.	BROADCAST RADIO (AM or FM) (metro size to interstate service area; narrowband; voice, slow video; data; one-way)	1	2	3	4	5	6	7
E.	TELEPHONE (virtually unlimited service area; narrowband; voice, slow video, data; fully switched two-way, conference calls make it n-way)	1	2	3	4	5	6	7
F.	DBS (direct broadcast satellite) (service areas may correspond to U.S. time zones; voice, video, data; one-way)	1	2	3	4	5	6	7
G.	MDS (multipoint distribution service) (service area limited to one city and immediate surroundings; voice, video, data; one-way or two-way capable)	1	2	3	4	5	6	7
H.	LPTV (low power TV) (service area might extend to several communities; 6 MHz, voice, video, data, one-way)	1	2	3	4	5	6	7
I.	TERMINALS (addressability, numerical keypad, alpha-numeric keypad, microprocessor equipped or not)	1	2	3	4	5	6	7

Appendix B

II. Rating appropriateness of technologies for services: Two different scales are used in this section. One scale is used for telecommunication technologies (e.g. columns 1-10) and a different scale is used for terminal type (e.g. column 11).

Columns 1-10: Please rate each technology on each service using a seven point scale where 7=very appropriate technology and 1=very inappropriate technology to support a given service. These judgements should be based primarily on technical criteria, but you may wish to consider other factors such as economic viability. There should be an entry in columns 1-8 and may be entries in 9,10.*
Column 11: In the last column, please indicate which features or features (multiple choices allowed) the most appropriate terminal should have. Please use the coding scheme below:

1= addressable	5= non-addressable
2= microprocessor equipped	6= non-microprocessor equipped
3= alphanumeric keyboard (like typewriter)	7= numeric keyboard (like telephone)
4= memory	8= no memory

Thus, if the combination 1-2-7 is selected, this would describe a terminal which is addressable, has a microprocessor and uses a numeric keypad.

* NOTE: If there is another technology not mentioned, or a hybrid of existing technologies (e.g. broadcast TV plus telephone) which you feel are appropriate for one or more services, please indicate this on your questionnaire.

	One-way cable TV	Two-way cable TV	Broadcast TV	Broadcast radio	Telephone	DBS	MDS	LPTV	Hybrid (specify)	OTHER (specify)	Terminal type
A. A service that would connect a computer to your home to provide automatic fire and burglar alarms?											
B. A service which would let you play different kinds of video games from your home?											
C. A service that would connect a computer to your home to automatically read your utility meters?											
D. A service that would connect a computer to your home to automatically turn down the hot water heater and the heat or air-conditioning in your house when they are not needed, in order to save money?											
E. A service that would let you vote from home in local elections or opinion polls?											
F. A service that would let you take school courses for college credit, if you wish, where you could ask questions or send answers automatically from your home?											
G. A service that would let you get special interest information which could be shown as words and pictures on your television screen? This is the kind of information you might normally get by going to the library.											
	1	2	3	4	5	6	7	8	9	10	11

Appendix B

	One-way cable TV	Two-way cable TV	Broadcast TV	Broadcast radio	Telephone	DBS	MDS	LPTV	Hybrid (specify)	OTHER (specify)	Terminal type
H. A service that would let you send or read messages to other people which could be shown on your television set instead of using paper? Some people call this electronic mail since it is like the regular mail service in some ways.											
I. A service that would let you do things like find out the balance of your bank accounts?											
J. A service that would let you pay bills automatically from your house?											
K. A service that would let you get general interest information which could be shown as words and pictures on your television set? This would be the kind of information you could usually get by going to a newsstand, for example.											
L. A pay-per-view movie service that would let you pay only for those movies that you actually watched, rather than paying a flat rate?											
M. A service which would let you automatically signal a medical emergency in your home?											
N. A service which would help you do math problems like keeping track of household finances, doing taxes, or doing homework?											
O. Capability to have all of the words and pictures be shown in color on your television set?											
P. Capability to get information immediately after you decide you want it?											
Q. Capability to provide pictures such as graphs or charts to help you understand results from math problems?											
R. Capability to use these services and <u>not</u> have to learn a computer language like BASIC or FORTRAN?											
S. Capability to have a typewriter-like keyboard which would let you type full messages instead of simple yes/no responses?											
T. Capability to keep all of your household bookkeeping in a computer?											
U. Provides a useful way to index your bookkeeping records so you can get the information you want more easily?											
	1	2	3	4	5	6	7	8	9	10	11

Appendix B

III. Demographics

A. How long have you been a member of HCT? _____ (months)

B. What is your academic rank or professional title?

(_____)

C. Please list the academic areas in which you have earned degrees.

Degree	Area
B.A.	_____
M.A./M.S.	_____
Ph.D.	_____
Other	_____

D. In addition to ICA, with what other professional associations do you affiliate?

_____ SCA _____ AEJ

_____ IEEE _____ MAPOR

_____ ACM _____ OTHER (please specify) _____

E. What technically oriented journals, if any, do you read? (Please list)

_____ _____

_____ _____

_____ _____

_____ _____

F. Age: _____ (years)

G. Gender: (1) Female (2) Male

Appendix B

MICHIGAN STATE UNIVERSITY

DEPARTMENT OF TELECOMMUNICATION

EAST LANSING • MICHIGAN • 48824

September 3, 1982

Dear Fellow HCT Member:

About two weeks ago you should have received a questionnaire from me on different types of technology and services which are relevant to home consumers of telecommunication. This instrument is part of a Delphi study I am conducting in association with my dissertation research. This project is not officially associated with either the International Communication Association or the Human Communication Technology special interest group.

I am writing again to thank those people who have already responded and to urge those who have not yet responded to please do so. Your responses are very important, as you know. With Maureen Beninson's help, the sample I selected for this study was to contain people most likely to be familiar with the concepts in the questionnaire. Several people have written back to me indicating that they wished to disqualify themselves from the panel because they did not feel comfortable with the content of the study. This is important information for me to have.

Summer is a difficult time to conduct a study, everyone seems to have a hectic schedule. But I would very much appreciate your help in completing this first round. As soon as the response rate is high enough, I can tabulate the Round One data and begin the Round Two process. If you have misplaced the questionnaire I have sent you, or if my first letter never reached you for some reason, please let me know.

Thank you again, one and all, for taking time out of your busy schedules to help me.

Warm best regards,

Richard V. Ducey
(517)353-6410

APPENDIX C

APPENDIX C

INSTRUMENTATION FOR DELPHI STUDY - WAVE II

MICHIGAN STATE UNIVERSITY

DEPARTMENT OF TELECOMMUNICATION — EAST LANSING • MICHIGAN • 48824

October 14, 1982

Dear Fellow HCT Member:

I would like to ask for your help in completing a Delphi study on telecommunication technologies and services. I want to thank those of you who were able to participate in the first round of this study. I hope more people will be able to join us in this second round. I think this will be the final round because of the overall consistency of estimates obtained in the first round of this study.

As you know, the goal of a Delphi study is to generate a consistent or at least stable set of group-based judgements regarding some phenomena. To accomplish this, a respondent group is surveyed at least twice. The first survey is to obtain initial perceptions from the group. The second survey enlightens respondents to overall group opinion and provides the opportunity for individuals to make a second set of judgements based on a knowledge of how their peers have reacted in the first survey. In this second round, I have enclosed an instrument which is modified from the first round survey which does two things: (1) summarizes data from the first survey; and (2) asks you to make a second set of judgements in light of these data.

The purpose of this study is to develop a reliable set of estimates regarding the extent to which various telecommunication technologies can provide a number of teleservices. In this study, the focus of interest in the telecommunication link and the terminal device which would be used in providing the teleservices.

I have enclosed a self-addressed and stamped return envelope. Please use this to return the survey instrument as soon as you have completed it. Hopefully, you will be able to complete this and have it in the mail before the end of this month.

I am sincerely grateful for your help in this study. Thank you for contributing your time and expert knowledge to my project. Please call or write if you have any further questions.

Warm best wishes,

Richard V. Ducey
(517) 353-6410

RVD:aia

Enclosures

Appendix C

Directions for Round II Delphi Survey

Section I: Self Rating on Technologies

1. Please rate your technical knowledge on the seven point scale indicated (1 = not knowledgeable; 7 = knowledgeable).
2. "Technical Knowledge" means the degree to which you are familiar with the capabilities and limitations of each technology described for providing the kinds of services considered in this study.

Section II: Technologies and Services

1. I have enclosed a description of services A-U for your reference.
2. The task is to rate each telecommunication medium on each service using a seven point scale where: 1 = very inappropriate technology; 7 = very appropriate technology to support a given service.
3. These judgements are subjective by nature, but should be grounded in considerations of technical attributes of the medium. Other considerations, such as economic viability of providing different services via each medium may also influence your judgements.
4. In this section, I have provided a measure of central tendency (mean) and dispersion (standard deviation) to summarize Round I data.
5. Please indicate your estimate (using the 7 point scale described in (2) above) in the blank provided.

Section III: Terminals

1. Terminal design attributes are coded 1-8. These are described on the survey instrument itself.
2. The task is to indicate which feature or features (multiple choices allowed) the most appropriate terminal should have.
3. "Appropriate" means features which would be needed for the service to be functional.
4. One of the Round I respondents suggested another attribute - hard copy printing capability. If you think this attribute is needed for a given service please circle the letter corresponding to that service in Column 1 of the table presented in Section III.

Section IV: Demographics

This section is fairly straightforward.

Appendix C

[illegible] Survey
October 1982
Round Two

DIRECTIONS: This questionnaire is divided into several sections. The first section provides a few key word descriptors of each technology in terms of (1) geographical service area, (2) bandwidth, (3) one-way vs. two-way and (4) type of communication voice, video, data. In this section you are asked to rate your own technical knowledge with respect to the technologies. In the next section you are asked to estimate the extent to which each telecommunication technology can support each service, and which type of terminal is most appropriate for each service. Finally, some demographic questions are asked to assist in the analysis of these data.

I. Self Rating on Technologies: For each technology described, please rate your technical knowledge on a seven point scale where: 7= knowledgeable and 1= unknowledgeable about this technology.

	Not Knowledgeable						Knowledgeable
A. ONE-WAY CABLE TV (limited service area--one or two towns; broadband; one-way only; voice, video and data)	1	2	3	4	5	6	7
B. TWO-WAY CABLE TV (same as above, but data communication can be returned from the home, making it two-way)	1	2	3	4	5	6	7
C. BROADCAST TV (UHF or VHF) (metro size service area; 6 MHz; one-way; voice, video, data, one-way)	1	2	3	4	5	6	7
D. BROADCAST RADIO (AM or FM) (metro size to interstate service area; narrowband; voice, slow video; data; one-way)	1	2	3	4	5	6	7
E. TELEPHONE (virtually unlimited service area; narrowband; voice, slow video, data; fully switched two-way, conference calls make it n-way)	1	2	3	4	5	6	7
F. DBS (direct broadcast satellite) (service areas may correspond to U.S. time zones; voice, video, data; one-way)	1	2	3	4	5	6	7
G. MDS (multipoint distribution service) (service area limited to one city and immediate surroundings; voice, video, data; one-way or two-way capable)	1	2	3	4	5	6	7
H. LPTV (low power TV) (service area might extend to several communities; 6 MHz, voice, video, data, one-way)	1	2	3	4	5	6	7
I. TERMINALS (addressability, numerical keypad, alpha-numeric keypad, microprocessor equipped or not)	1	2	3	4	5	6	7

Appendix C

II. Technologies & Services -2-

Medium: One-way Cable TV

Service	Mean	S.D.	Your Estimate
A	1.842	1.893	
B	2.632	2.166	
C	1.895	1.997	
D	1.737	1.628	
E	1.579	1.575	
F	1.889	1.779	
G	2.895	2.424	
H	1.056	0.236	
I	1.895	1.997	
J	1.368	1.383	
K	3.579	2.755	
L	4.053	2.549	
M	1.947	2.121	
N	1.611	1.787	
O	6.056	1.924	
P	1.667	1.782	
Q	2.526	2.144	
R	4.188	2.949	
S	2.000	2.171	
T	1.211	0.918	
U	1.222	0.943	

Medium: Two-way Cable TV

Service	Mean	S.D.	Your Estimate
A	6.100	1.586	
B	6.150	1.309	
C	6.400	1.314	
D	5.650	2.110	
E	6.300	1.418	
F	6.350	0.933	
G	6.250	0.910	
H	6.158	1.015	
I	6.050	1.432	
J	5.850	1.872	
K	6.250	0.910	
L	6.400	1.231	
M	6.200	1.508	
N	4.842	2.433	
O	6.333	1.029	
P	6.211	0.976	
Q	5.750	1.650	
R	6.000	1.372	
S	6.294	1.160	
T	4.700	2.473	
U	4.778	2.463	

Medium: Broadcast TV

Service	Mean	S.D.	Your Estimate
A	1.000	0.000	
B	1.789	1.437	
C	1.000	0.000	
D	1.000	0.000	
E	1.389	1.243	
F	1.833	1.790	
G	2.579	2.219	
H	1.000	0.000	
I	1.053	0.229	
J	1.000	0.000	
K	3.211	2.616	
L	2.842	2.522	
M	1.000	0.000	
N	1.222	0.943	
O	6.000	2.033	
P	1.500	1.465	
Q	2.500	2.176	
R	4.250	3.000	
S	1.933	2.120	
T	1.000	0.000	
U	1.000	0.000	

Medium: Broadcast radio

Service	Mean	S.D.	Your Estimate
A	1.000	0.000	
B	1.526	1.307	
C	1.000	0.000	
D	1.000	0.000	
E	1.389	1.243	
F	1.889	1.906	
G	1.833	1.757	
H	1.000	0.000	
I	1.000	0.000	
J	1.000	0.000	
K	2.316	2.405	
L	1.000	0.000	
M	1.000	0.000	
N	1.111	0.471	
O	1.267	1.033	
P	1.389	1.243	
Q	1.500	1.339	
R	3.938	2.955	
S	1.800	2.111	
T	1.000	0.000	
U	1.000	0.000	

Appendix C

II. (cont.)

Medium: Telephone

Service	Mean	S.D.	Your Estimate
A	5.900	1.447	
B	4.900	1.997	
C	5.200	1.824	
D	4.650	2.231	
E	5.474	2.038	
F	4.895	2.208	
G	4.500	2.646	
H	5.474	2.038	
I	6.250	1.209	
J	6.300	0.923	
K	4.950	2.328	
L	1.842	2.007	
M	6.650	0.813	
N	4.158	2.588	
O	2.250	2.324	
P	5.944	1.731	
Q	3.778	2.647	
R	5.611	2.173	
S	5.278	2.321	
T	4.100	2.770	
U	4.150	2.720	

Medium: DBS

Service	Mean	S.D.	Your Estimate
A	1.105	0.315	
B	1.421	0.961	
C	1.105	0.315	
D	1.053	0.229	
E	1.278	0.826	
F	1.833	1.724	
G	2.316	2.136	
H	2.056	1.862	
I	1.368	1.383	
J	1.316	1.376	
K	2.789	2.463	
L	3.579	2.714	
M	1.421	1.305	
N	1.000	0.000	
O	5.875	1.996	
P	1.944	2.182	
Q	2.667	2.326	
R	4.250	3.000	
S	2.333	2.469	
T	1.316	1.376	
U	1.333	1.414	

Medium: MDS

Service	Mean	S.D.	Your Estimate
A	3.263	2.469	
B	3.789	2.250	
C	3.368	2.565	
D	3.421	2.631	
E	3.722	2.761	
F	4.222	2.439	
G	4.000	2.494	
H	3.389	2.547	
I	2.895	2.514	
J	2.842	2.544	
K	4.000	2.603	
L	4.421	2.673	
M	2.895	2.492	
N	1.722	1.776	
O	5.250	2.380	
P	3.333	2.744	
Q	3.389	2.570	
R	4.813	2.536	
S	3.313	2.798	
T	2.158	2.167	
U	1.895	2.079	

Medium: LPTV

Service	Mean	S.D.	Your Estimate
A	1.053	0.229	
B	1.684	1.416	
C	1.053	0.229	
D	1.000	0.000	
E	1.444	1.338	
F	2.000	1.970	
G	1.833	1.505	
H	1.111	0.471	
I	1.053	0.229	
J	1.000	0.000	
K	2.316	2.083	
L	2.842	2.410	
M	1.211	0.713	
N	1.278	1.179	
O	4.688	2.651	
P	1.444	1.294	
Q	2.222	2.102	
R	3.875	3.008	
S	2.188	2.455	
T	1.316	1.376	
U	1.316	1.376	

Appendix C

III. Terminals -4-

Terminal Designs

	Attributes Selected (in %; N=20)*							
Service	1	2	3	4	5	6	7	8
A	88.2 ___	58.8 ___	11.8 ___	23.5 ___	5.9 ___	5.9 ___	17.6 ___	35.3 ___
B	66.7 ___	88.9 ___	72.2 ___	77.8 ___	11.1 ___	5.6 ___	22.2 ___	11.1 ___
C	87.5 ___	43.8 ___	6.3 ___	25.0 ___	6.3 ___	25.0 ___	12.5 ___	43.8 ___
D	94.1 ___	58.8 ___	35.3 ___	47.1 ___	15.0 ___	11.8 ___	15.0 ___	23.5 ___
E	82.4 ___	41.2 ___	52.9 ___	29.4 ___	15.0 ___	23.5 ___	58.8 ___	29.4 ___
F	83.3 ___	83.3 ___	94.4 ___	83.3 ___	5.6 ___	5.6 ___	5.6 ___	0.0 ___
G	83.3 ___	77.8 ___	94.4 ___	72.2 ___	5.0 ___	11.1 ___	11.1 ___	11.1 ___
H	93.8 ___	87.5 ___	100.0 ___	93.8 ___	0.0 ___	0.0 ___	6.3 ___	0.0 ___
I	88.9 ___	55.6 ___	55.6 ___	50.0 ___	0.0 ___	16.7 ___	50.0 ___	22.2 ___
J	88.2 ___	64.7 ___	76.5 ___	58.8 ___	5.9 ___	11.8 ___	29.4 ___	11.8 ___
K	76.5 ___	64.7 ___	88.2 ___	70.6 ___	11.8 ___	11.8 ___	11.8 ___	5.9 ___
L	80.0 ___	26.7 ___	20.0 ___	33.3 ___	13.3 ___	40.0 ___	53.3 ___	40.0 ___
M	81.3 ___	50.0 ___	37.5 ___	43.8 ___	12.5 ___	25.0 ___	50.0 ___	31.3 ___
N	68.8 ___	81.3 ___	93.8 ___	87.5 ___	12.5 ___	6.3 ___	12.5 ___	6.3 ___
O	30.0 ___	30.0 ___	40.0 ___	20.0 ___	60.0 ___	60.0 ___	30.0 ___	60.0 ___
P	66.7 ___	73.3 ___	80.0 ___	73.3 ___	20.0 ___	13.3 ___	20.0 ___	13.3 ___
Q	64.7 ___	76.5 ___	76.5 ___	70.6 ___	17.6 ___	11.8 ___	23.5 ___	11.8 ___
R	71.4 ___	78.6 ___	78.6 ___	85.7 ___	21.4 ___	14.3 ___	21.4 ___	7.1 ___
S	66.7 ___	73.3 ___	93.3 ___	73.3 ___	13.3 ___	6.7 ___	13.3 ___	6.7 ___
T	75.0 ___	87.5 ___	81.3 ___	93.8 ___	6.3 ___	6.3 ___	25.0 ___	0.0 ___
U	60.0 ___	86.7 ___	93.3 ___	86.7 ___	20.0 ___	0.0 ___	20.0 ___	0.0 ___

*Due to some missing data, not all percentages are based on 20 responses.

DIRECTIONS: In this table, percentages of people selecting each attribute for each service are indicated. In the space to the right of the data from Round One of this study, please place a check if you feel that a terminal providing the given service would need this attribute. In other words, for service C, 6.3% of the respondents in Round I indicated that attribute #3 (alphanumeric keyboard) would be needed. If I agreed with this, I would place a check in the blank next to the 6.3. Otherwise, I would leave that spot blank.

CODING SCHEME:

1= addressable
2= microprocessor equipped
3= alphanumeric keyboard (like typewriter)
4= memory
5= non-addressable
6= non-microprocessor equipped
7= numeric keyboard (like telephone with push buttons)
8= no memory

Thus, a combination of 1-2-7 describes a terminal which is addressable, has a microprocessor and uses a numeric keypad.

Appendix C

III. Demographics

A. How long have you been a member of HCT? _____ (months)

B. What is your academic rank or professional title?

(_____)

C. Please list the academic areas in which you have earned degrees.

Degree	Area
B.A.	_____
M.A./M.S.	_____
Ph.D.	_____
Other	_____

D. In addition to ICA, with what other professional associations do you affiliate?

_____ SCA _____ AEJ

_____ IEEE _____ MAPOR

_____ ACM _____ OTHER (please specify) _____

E. What technically oriented journals, if any, do you read? (Please list)

_____ _____

_____ _____

_____ _____

_____ _____

F. Age: _____ (years)

G. Gender: (1) Female (2) Male

H. Did you participate in Round One of this Delphi survey?

_____ YES _____ NO

THANK YOU AGAIN FOR YOUR PATIENCE AND COOPERATION IN CONDUCTING THIS SURVEY!!!

A. A service that would connect a computer to your home to provide automatic fire and burglar alarms?

B. A service which would let you play different kinds of video games from your home?

C. A service that would connect a computer to your home to automatically read your utility meters?

D. A service that would connect a computer to your home to automatically turn down the hot water heater and the heat or air-conditioning in your house when they are not needed, in order to save money?

E. A service that would let you vote from home in local elections or opinion polls?

F. A service that would let you take school courses for college credit, if you wish, where you could ask questions or send answers automatically from your home?

G. A service that would let you get special interest information which could be shown as words and pictures on your television screen? This is the kind of information you might normally get by going to the library.

H. A service that would let you send or read messages to other people which could be shown on your television set instead of using paper? Some people call this electronic mail since it is like the regular mail service in some ways.

I. A service that would let you do things like find out the balance of your bank accounts?

J. A service that would let you pay bills automatically from your house?

K. A service that would let you get general interest information which could be shown as words and pictures on your television set? This would be the kind of information you could usually get by going to a newsstand, for example.

L. A pay-per-view movie service that would let you pay only for those movies that you actually watched, rather than paying a flat rate?

M. A service which would let you automatically signal a medical emergency in your home?

N. A service which would help you do math problems like keeping track of household finances, doing taxes, or doing homework?

O. Capability to have all of the words and pictures be shown in color on your television set?

P. Capability to get information immediately after you decide you want it?

Q. Capability to provide pictures such as graphs or charts to help you understand results from math problems?

R. Capability to use these services and <u>not</u> have to learn a computer language like BASIC or FORTRAN?

S. Capability to have a typewriter-like keyboard which would let you type full messages instead of simple yes/no responses?

T. Capability to keep all of your household bookkeeping in a computer?

U. Provides a useful way to index your bookkeeping records so you can get the information you want more easily?

Appendix C

MICHIGAN STATE UNIVERSITY

DEPARTMENT OF TELECOMMUNICATION EAST LANSING · MICHIGAN · 48824

November 16, 1982

Dear Fellow HCT Member:

About three weeks ago you should have received a questionnaire from me on different types of technologies and services which are relevant to home consumers of telecommunication. This instrument constitutes the second round of a Delphi Study which I am conducting as part of my dissertation research. This project is not officially associated with either the International Communication Association or the Human Communication Special Interest Group.

I am writing again to thank those people who have already responded and to urge those who have not yet had a chance to respond, to please do so. As you know, all responses are very important.

Even if you did not participate in Round One of this Delphi Study, please feel free to participate in Round Two. I very much appreciate all of your assistance and patience with this project. If you have misplaced the questionnaire I sent you, or if you have any other questions please call or write to me.

Many thanks for your support.

Warm best regards,

Richard V. Ducey
(517) 353-6410

RVD:aia