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The PLATO system : a study in the diffusion of an innovation.

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THE PLATO SYSTEM: A STUDY IN THE DIFFUSION OF AN INNOVATION

A Dissertation Presented

By

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ABSTRACT

THE PLATO SYSTEM: A STUDY
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Although continuous attempts, some successful, have been made to implement innovations within a social science/educational framework, there has been a dearth of technology which addresses how an innovation should be diffused. Particularly lacking have been prescriptive guidelines usable by linkage agents. The Wolf-Welsh Linkage Methodology (now in its sixth revision) has been developed to aid linkage agents in the effective adoption and implementation of innovative products, ideas, and practices. The purpose of this study is to determine if the Wolf-Welsh Linkage Methodology is an effective linkage tool. To overcome endemic difficulties in using the Methodology to diffuse a new product, idea, or practice, the study is *ex post facto* in nature. It studies the diffusion of the PLATO computer-based educational system during 1972-1976, during which substantial sums of money were committed to develop an implementation and demonstration project. The procedure used to gather data was to visit some funding agencies (National Science Foundation and Ford Foundation) and to obtain documents from other funding sources (Kettering Foundation). Also, a visit was made to the University of Illinois, the creator of PLATO, at which time interviews were held and relevant documents were reviewed. The data was analyzed to determine if the process of diffusion used for the PLATO system fit within the framework of the Methodology and also to determine if use of the Methodology could have been helpful in the diffusion of PLATO. The results show that the diffusion of PLATO followed closely the seven steps which are the framework of the Methodology and that the use of the Methodology could have alerted the PLATO linkage agents to potential problems and have prescribed remedial action. The conclusion reached is that the Wolf-Welsh Linkage Methodology can be a valuable and efficient tool for linkage agents and for those whose responsibilities include the adoption and/or implementation of innovative produces, ideas, and practices.

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CHAPTER I

AN OVERVIEW OF THE STUDY

The Problem

The American Telephone and Telegraph Corporation evolved a knowledge production, diffusion and utilization system during the Twentieth Century that met needs of many people effectively for decades. The system included: Bell Telephone Laboratories, a unit dedicated to invention and innovation; Western Electric, a unit responsible for the translation of new practices, products and ideas into forms that can be utilized within the A.T. and T. system; and numerous regional telephone subsidiaries, units responsible for the delivery of varied communication services designed to meet needs of clients. A.T. and T.'s system is an example of a research, development, diffusion, and utilization model that worked extremely well. Many large corporations, certain branches of the military, and certain federal government agencies have been able to make use of a model like or similar to the A.T. and T. version.

What was learned and institutionalized within organizations like the telephone company has influenced knowledge production, diffusion, and utilization practices elsewhere. However, the influence cannot be described as pervasive. Educational institutions and systems, municipal and state governments, religious institutions, small businesses, and unions and similar associations, have not benefitted perceptibly from such know-how. These organizations aren't likely to benefit perceptibly in the near future either, because they aren't like A.T. and T.

A large set of organizations - such as A.T. and T. - have evolved within our society and are driven by forces such as charismatic personalities, fortuitous circumstances, and expediencies on the one hand, and restrained by forces such as traditions, social conventions, governmental rules, financial institutions, and prior experiences on the other. Often the former and the latter forces are in conflict. Peculiar causes - for

> example, "Change for the sake of change," and, "Don't just do something, stand there," - have been championed within these organizations as one consequence of the conflict. Another consequence has been erratic and unpredictable knowledge production, diffusion, and utilization practices.
>
> - W.C. Wolf, Jr.

Diffusion is defined as ". . . the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1983, p. 34). An innovation is a product, idea or practice perceived to be new by an individual or group. A diffusion research tradition has developed in recent years consisting of an integrated body of concepts and generalizations developed by investigators from traditions as varied as marketing and anthropology (Rogers, 1983). One of the components of diffusion is how linkage or change agents function in the communication of the innovation. Study of that component becomes difficult since erratic and unpredictable knowledge diffusion and knowledge utilization practices associated with many of the organizational categories suggested by Wolf in the quotation cited above thwart rational study. Classic communication models - for example, a model encompassing a message sender, a message, a message receiver, and feedback loops - portray diffusion/utilization enterprise within closed systems reasonably well. Open and/or amorphously-defined systems introduce complexities that extend beyond the so-called classic models. Unfortunately, many examples of the latter systems exist to obfuscate reality (Wolf, 1987).

The Cooperative Education Service (CES) of the U.S. Department of Agriculture illustrates a complex, closed system that has been studied extensively (Rogers & Shoemaker, 1971). The system encompasses knowledge producers (university-based and corporate research centers), linkage agents (agricultural extension personnel affiliated with state universities), and knowledge users (agricultural entrepreneurs like farmers), integrated with a two-way information flow network. Rural sociologists have focused upon CES and similar contexts to provide a rich, quantitatively based research resource during the past three or four decades. Other sociologists, anthropologists, educators, communication studies specialists, and marketing studies specialists, among others, have expanded and given depth to the work of the rural sociologists (Rogers, 1962; Rogers & Shoemaker, 1971; Rogers, 1983).

Contributions of these specialists to the base of know-how pertaining to knowledge diffusion and knowledge utilization include the following:

1. Knowledge utilization appears to adhere often to a S-shaped curve when plotted against time (Rogers & Shoemaker, 1971).
2. Mathematical models have been conceived to portray knowledge utilization phenomena (Lawton & Lawton, 1976).
3. Knowledge diffusion involves specific stages, the number of which remains unclear (Havelock, 1973; Zaltman & Duncan, 1977).

4. Characteristics of innovations are known that influence their utilization by members of targeted audiences (Havelock, 1973).
5. Members of targeted audiences respond to innovation diffusion initiatives differently; they do not respond as if they were interchangeable parts (Wolf, 1984).

Generalizations like the above appear to be more stable within closed rather than open systems.

Open systems introduce so many unanticipated and uncontrolled variables, that the "packages of conventional wisdom" aren't frequently applicable within these contexts. New approaches that are able to draw upon what has been learned about closed systems and that relate knowledge obtained to open systems meaningfully are needed. Few alternative approaches have emerged (Wolf, 1987).

One approach deemed to be of potential value focuses upon what occurs between the time "new" knowledge is offered and needs of knowledge users are met. Researchers have addressed variables and roles relevant to this linkage phase quite aggressively during the past ten to fifteen years. Much data of value has been generated; much work is still called for to configure these data meaningfully. A perspective of these efforts is provided in the following paragraphs.

Many people, across a variety of disciplines, have assumed responsibilities in recent decades for bridging gaps which sometimes exist between knowledge producers and knowledge users within organizations when production and use of knowledge is undertaken by different groups or individuals. Whether they are called a county agent, field representative, idea person, curriculum coordinator, principal, marketing coordinator, or sales representative, for example, all share a common concern - linkage. Persons engaged in linkage are often referred to in the current literature as "linkage agents" or "change agents."

Linkage agents typically spend their days navigating--with varying degrees of success--between Scylla and Charybdis. They are expected to make things happen. The "happenings" may be clearly defined and attainable, they may be clearly defined but unattainable, they may be fuzzy concepts which may or may not be attainable, and, they may be unknowns which require invention. Considerable variance characterizes the manner in which linkage agents attempt to make things happen within organizations, because neither standardized procedures nor blueprints exist to guide their actions (Wolf, 1987).

Researchers have learned much about relationships between (a) the process of innovation adoption, (b) attributes of innovations, and (c) adopter characteristics on the one hand and the rate of adoption of innovations on the other hand (Miles, 1964; Rogers, 1983). Unfortunately, what has been learned about these kinds of relationships has not been translated into convenient forms apt to be used by linkage agents in their work. Most linkers don't have the time available to seek out and then integrate outcomes of research meaningfully; they do not command technical skills required to interpret outcomes of related research; and, they are not able to transform research results into forms apt to be incorporated within personal practice. Hence, research outcomes fail - all too often - to impact meaningfully upon knowledge diffusion and knowledge utilization practices within organizations.

While "convenient forms" may not exist, there are resources evolving which aspire to link knowledge production and needs of knowledge users within organizations. Some of these resources may help linkage agents navigate judiciously between the twin terrors of their practice - that is, change for the sake of change (Scylla) and institutional rigor mortis (Charybdis). What follows is an account of the evolution of several unique products which were designed to upgrade the caliber of linkage agent performance within organizational settings. Work began on the concept undergirding the products more than a decade ago, and work continues. The account illustrates how communication researchers can capitalize upon prior work and shape what has been learned to meet current needs.

Appendix A of Rogers and Shoemaker's <u>Communication of Innovations</u> offers scores of "generalizations" about the diffusion of innovations which were gleaned from empirical studies completed within one of eighteen disciplines scanned. Wolf and his associates at the University of Massachusetts at Amherst adopted the Rogers and Shoemaker approach to research integration to develop generalizations and focused their energy upon research outcomes pertaining to linking knowledge production and needs of knowledge users.

They sought information from research and development sources cited in one or more of the following collections: the library card catalogue, the _Readers' Guide_, the _Education Index_, ERIC resources (Resources in Education and the Current Index to Journals in Education), the Department of Defense documents center, _Dissertation Abstracts_, and _Psychological Abstracts_. Books written by Rogers and Shoemaker (1971), Lionberger (1960), Havelock (1969), Gross et al. (1971), Ross (1958), Glaser and Davis (1976), and Zaltman and Duncan (1977), along with reports by Maguire (1970), Short (1973), and Piele (1975), were used extensively to identify appropriate "diffusion generalizations." The array of "generalizations" obtained were then arranged according to their common properties. What emerged was six classes of generalizations of apparent importance to linking knowledge production and needs of knowledge users. It was now possible to describe the classes of generalizations as specific variables, and to juxtapose the identified variables according to perceived relationships among the set. Figure 1 portrays the variables and the relationships perceived.

Each of the variable classes included in the configuration represents a set of related components which have been the focal point of research across numerous disciplines. The six classes of variables consist of twenty-six different components: three are related to conditions for change; five to characteristics of the innovator of linker; seven to characteristics of the innovation; five

Figure 1. Perceived Relationships of Classes of Variables Believed to be of Importance to the Linkage Process

Classes of Antecedent Variables	Classes of Manipulable Variables	Classes of Outcome Variables
Conditions for change	Characteristics of linkage or diffusion strategy	Characteristics of adoption or utilization decisions
Characteristics of innovator or linker		Characteristics of rejection decisions
Characteristics of innovation		
Characteristics of adopting units		Characteristics of deferred action decisions

to characteristics of the adopting units; four to characteristics of the linkage or diffusion strategy; and two to outcomes. While the configuration may not reflect the complete set of relevant resources pertaining to linking knowledge production and needs of knowledge users, the assemblage is certainly a healthy representation of the complete set.

The configuration described above served as a point of departure for a series of diffusion/utilization studies by Wolf and his associates. These studies were focused upon how to link the world of knowledge production with needs of knowledge users. Work completed by Wolf and Fiorino (1973), Hutchinson (1975), Welsh (1976), Allan (1976), Goodman (1976), and Thayer (1981), between 1973 and 1981, made clear: (a) specific variables and processes to be addressed; (b) a modus operandi, called metamethodology, for addressing the variables and processes; and (c) how to apply outcomes of the enterprise.

These inquiries contributed to the development of two instruments which were designed to meet needs of knowledge users within organizational settings. The first instrument is a linkage methodology, called the Wolf-Welsh Linkage Methodology (Appendix A), that has been designed to guide linkage agents in the diffusion of an innovation. It is the tool used in this study. The second instrument is a survey inventory, called the Wolf Knowledge Diffusion/Utilization Inventory, which has been designed to generate data needed by linkers (Wolf, 1987).

Utilization and validation of the two linkage tools has proven to be a most complex challenge. The challenge involves: (a) training persons to be able to implement the two instrument; (b) locating an organizational context about to embark upon a change venture; (c) obtaining resources to facilitate work envisioned; and (d) evaluating both the instruments' implementation as well as consequences of the change initiative. Two problems have thwarted the developer's efforts for the past several years.

Problem One. Getting linkage agents to try out and/or make use of tools for innovation diffusion is not easy. Persons who enroll in a graduate-level seminar with Wolf at the University of Massachusetts are most likely to try out and to incorporate the tools within their professional practice and offer feedback; persons who participate in one- or two-day in-service workshops with him occasionally try out and incorporate one or both tools within their professional practice; whereas, persons who read published articles pertaining to the tools, attend speech and paper presentations, or who request copies of the tools (he has given away hundreds of copies), seldom seem sufficiently aroused to try out or incorporate one or both tools within their professional practice. Wolf has been frustrated by an inability to get the two tools tried out or incorporated within the practice of larger numbers of persons charged with linkage responsibilities.

Problem Two. People who utilize the two tools seldom commit the time required to address the evaluation steps of the Methodology systematically. What is received as an evaluation of the efficacy of Steps (Parts) I through VII of the Methodology tends to be in the form of testimonials rather than careful documentation.

Application of the two tools in an ex post facto manner has proven to be a productive exception to this dilemma. Amburgey (1983) and Radlo (1978) pioneered such an application with considerable success. Both conceived a study within which the Wolf-Welsh Linkage Methodology was used to make sense of data drawn from the archives of state and federal agencies. Study outcomes exceeded expectations. Amburgey's and Radlo's inquiry mode is the focal point of this dissertation.

Purpose Statement

The purpose of the study is to ascertain relationships between the Wolf-Welsh Linkage Methodology, a tool designed to link knowledge production and needs of knowledge users on the one hand and milestones in the evolution of a successful innovation, the PLATO system, on the other. PLATO is an acronym for Programming Logic for Advanced Teaching Operations. It is a computer-assisted instruction system described in detail in Chapter III. Specific purposes of the study include the following:

1. To ascertain milestones in the evolution of the PLATO system which are believed to account for the system's widespread utilization.

2. To relate milestones discerned to specific components of the Wolf-Welsh Linkage Methodology in order to determine similarities, differences, and gaps of interest.
3. To pass judgment on the viability of the components of the Wolf-Welsh Linkage Methodology in light of data obtained.

Significance of Study

Education has long been characterized as an especially stable social system. Typically, a considerable amount of time occurs between the introduction of an innovation and its widespread utilization. Many innovations which seem to be quite worthy and which would have a substantial positive effect are either very slow in being adopted or are not adopted at all. For example, it took 50 years following the recognition of the need to establish the kindergarten before it became the required entry point into our school system. The Dvorak typewriter, conversely, has had little acceptance although statistics prove clearly that the keyboard arrangement is substantially more efficient than the standard or "QWERTY" typewriter (Rogers, 1983). There exists a need to learn more about events that transpire during the course of initiatives intended to alter personal and/or institutional practices.

The Wolf-Welsh Linkage Methodology (Wolf, 1979) has been designed to link knowledge production and needs of knowledge users. The tool yields clues as to why failures-to-adopt occur.

Capabilities of the tool are being clarified via varied field tests such as the one reported by this researcher.

The innovation against which the Wolf-Welsh Linkage Methodology is to be tested is the PLATO system, an extensive Computer-assisted Instruction and Computer-managed Instruction delivery system. This dissertation makes no attempt to join the argument of whether PLATO is a meritorious innovation. (Indeed, there are indications that the success of an innovation has little to do with its merits [Miles, 1964].) However, it does assume that its acceptance by over 100 colleges and universities as well as by corporate training programs shows that it has had substantial diffusion and adoption. It has been available for almost 20 years, suggesting that it has a good deal of survivability as well. PLATO's diffusion into academe is the interesting part and the subject of this research paper. Other systems similar to PLATO have not survived for long.

The researcher believes that, if PLATO came to be accepted because it developed in accordance with guidelines used to produce the Wolf-Welsh Linkage Methodology, evidence offered would help validate Wolf's approach. This would bode well for developing strategies to diffuse other innovations. It is also possible that the diffusion of PLATO did not follow the Wolf-Welsh guidelines, which would suggest that one or more parts of the Methodology need to be reconsidered.

Elaboration of Terminology

The field of study concerned with the diffusion of innovations has developed a standard set of terminology which will be used in this study. This also applies to the Wolf-Welsh Linkage Methodology. There is a need for a further set of definitions because the innovation, PLATO, has to do with the field of computer-based education which is relatively new. Consequently, common definitions do not yet have the precision we would desire. Such lack of operationalization continues to cause confusion.

The current definitive work in the study of the diffusion of innovations is that by Rogers (1983). The definitions in this study as they apply to this field are based generally on his work.

<u>Communication</u> - A process in which participants create and share information with one another in order to reach a mutual understanding.

<u>Compatibility</u> - The degree to which an innovation is perceived as consistent with the existing values, past experience, and needs of the receiver (adopter).

<u>Computer-assisted Instruction</u> - That portion of Computer-based Education which presents the educational modules.

<u>Computer-based Education</u> - The sum of Computer-assisted Instruction and Computer-managed Instruction.

Computer-managed Instruction - That portion of Computer-based Education which controls the educational process (automatic grading, student placement, and student progress).

Diffusion - The communication process through certain channels over time; dissemination.

Innovation - An idea, practice, or object that is perceived as new by an individual or other unit of adoption.

Linkage (Diffusion, Change) Agent - The medium by which an innovation is introduced to a potential innovator. The medium can be a person or an activity, such as advertising.

Recognized Shortcomings of the Study

An *ex post facto* study such as this has innate characteristics which need to be identified so that the results from the research can be used with confidence by others who have an interest in diffusion research and the Wolf-Welsh Linkage Methodology. The first is simply that the study is *ex post facto* in nature. The innovation (PLATO) was introduced over two decades ago, so the historical accuracy of its diffusion might be questioned.

An *ex post facto* study runs a risk of offering outcomes that aren't consonant with reality. This transpires for a variety of reasons, such as:

1. Access to all key players isn't uniform.
2. Interviewee recall varies and becomes blurred.

3. Data archives of importance aren't maintained carefully or aren't accessible.
4. An inability to structure available data to be compatible with data desired becomes apparent.

The researcher had difficulty in dealing with aspects of each of the above problems.

Finally, the Wolf-Welsh Linkage Methodology requires the categorization of data within the seven steps in such a way that the researcher could have been influenced in unforeseen ways during the execution of the study. For example, expectations of occurrences as indicated by the Methodology may have influenced what the researcher obtained. This is a subtle distinction that is difficult to address.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

A review of literature concerning the diffusion of innovations suggests that there have been a few major works from which others have drawn and many minor, sometimes episodic, works. The seminal studies by Rogers (1962, 1983) and by Rogers and Shoemaker (1971) were attempts to bring together significant findings from large numbers of studies concerning the diffusion/communication of innovations in various social sciences and in business. In discussing the research traditions concerning diffusion, Rogers and Shoemaker commented that, although there were a large number of studies in education, it was one of ". . . the lesser traditions in terms of its contributions to understanding the diffusion of innovations or to a theory of social change" (p. 58-59).

Mort's work is the first to deal with how innovations in education occur (1964). Miles pursued this line of reasoning by developing some generalizations concerning innovations in education (1964) and this approach (descriptive as opposed to prescriptive) has come to dominate educational innovation literature. Although Kuhn's work, The Structure of Scientific Revolution (1962), dealt with the natural sciences, its concept of shifting paradigms has impacted social science thinking as well. Oettinger's essay, Run, Computer, Run: The Mythology of Educational Innovation (1969), provided an analysis of why educational change and innovation was difficult to achieve. Kotler (1975) was one of the first to adopt commercial marketing techniques to the non-profit sector. Other major works in the general field of innovation, sometimes called planned change, are those by Bennis, Benne and Chin (1969) and Zaltman and Duncan (1977). Huberman and Havelock have written extensively in the field of planned change as well. Much of the effort of these writers has focussed on the development of generalizations and concepts gleaned from diffusion studies.

The approach to the review of literature taken here is a topical one. By breaking diffusion of innovation into component parts, it should be easier for the reader to see the specific contributions to the diffusion research tradition rather than to orient the review around the authors themselves. The topics covered in the review are: (1) adoption vs. implementation, (2) difficulties regarding change, (3) resistance to change, (4) strategies for change, (5) linkage (change) agents, and (6) institutions created to aid the diffusion of educational innovations. The reader should notice the paucity, almost absence, of literature on the subject which is prescriptive in nature. The consuming effort has been to describe how an innovation worked in a given setting at a given time, rather than how do the knowledge producer and linkage agent proceed to diffuse an innovation.

Adoption vs. Implementation

This section of the review is used as a preface. Although the two words have similar meanings, they describe two substantially different events (Berman, 1980). Loucks-Horsley and Cox (1984) identify three phases in the innovation process: initiation/adoption, implementation, and institutionalization. They state that many decisions to adopt an innovation have resulted in no change. Oettinger (1969) makes the same distinction between adoption and implementation and also raises the issue of innovations which were adopted but subsequently underwent major modifications. Spivak and Radnor (1979) define the two words on the basis of who is the performer; decision makers make adoption decisions and users make implementation decisions. Fidler and Johnson define implementation as consisting of ". . . the routinization, incorporation, and stabilization of the innovation into ongoing work activity" (p. 4-5). Adams and Chin (1981) mention implementation as ". . . any persisting change in the patterns of behavior of members of an identifiable social system . . ." (p. 224). Adoption occurs when formal approval is given to the innovation by decision makers. Implementation occurs when practitioners incorporate the innovation into their normal routine.

Difficulties Regarding Change

A diffusion structure frequently cited for its effectiveness is the one developed by the U.S. Department of Agriculture. This structure consists of three parts: the experiment station (the knowledge producers), the county extension field agents (the linkers), and the farmers (the users). It works well. In practice, the experiment station develops a new variety of a seed, for example. After extensive testing, a determination is made that the practice merits use by a group of farmers. The county extension field agents are advised of the new practice and in turn advise farmers who would likely be interested. Data is provided to show in quantitative terms what the results of the new practice were and under what conditions the results were achieved. The process is both efficient and effective. The danger in using this paradigm in the social sciences lies in taking such a tidy structure and expecting similar results to be achieved in a social or educational context which is likely to be much more complex. This section of the review will focus on some of the problems faced when change in a social or educational setting is attempted.

Oettinger (1969) describes the educational system as one ". . . bound to society in a way that is almost ideally designed to thwart change" (p. 215), where ". . . schools belong to everyone's experience . . ." and wherein ". . . the people who make up every other institution . . . are products of the schools" (p. 60). He identifies the vase number of individuals and institutions which, by being part of the school system in its broadest context, can influence or at least attempt to influence change. For example, when a United States Senator introduces a bill authorizing the expenditure of $100 million to implement science teaching via satellite, passage of such a bill will affect a vast number of school systems in the country. When the Supreme Court rules that school segregation is illegal and must be stopped forthwith, reverberations are felt from the deepest part of the South to the South End of Boston. When a wealthy alumnus or alumna endows a chair at a university, change will probably occur. External influences on educational systems are numerous and ostensibly significant.

What we identify is a process infinitely more complex than the experiment station, field agent and farmer process previously described. A substantial part of diffusion theory is based on an awareness and understanding of why change is difficult. It has continued to occupy the attention of many diffusion researchers.

A major and fundamental area of concern has been the quality of the social science research itself. Concern has been expressed that social science researchers have low prestige and, therefore, are not able to attract first-rate talent to their respective disciplines (Spivak & Radnor, 1977; Myrdal, 1968). Furthermore, the social science research model-builders have disassociated research from life (Myrdal, 1968). What ensues is researchers writing for each other rather than for the layman/practitioner and an isolation of social science researchers from researchers in other disciplines (Kuhn, 1962; Spivak & Radnor, 1979).

The problems social science/educational researchers are trying to solve are difficult (Myrdal, 1968). One of the outcomes of this is that there is difficulty in describing such research in ". . . operational terms . . ." (Spivak & Radnor, 1979). Instead, "the literature on the diffusion and use of innovations consists of opinions . . ." and ". . . observations of experiences, including descriptions of what in the author's opinion seemed to be the key variables in the process of getting their innovations used" (Stalz, 1983). To repeat, focus has been to describe how an innovation was diffused rather than to prescribe how one should be diffused.

The inability to manipulate variables effectively in much social science and educational research limits the external validity of innovation studies and the likelihood that implementation can take place in other settings without adaptation (Loucks, 1983). Researchers have emphasized a basic need for proper evaluation and documentation of innovative projects and beyond that a ". . . technology to disseminate innovative service systems to practitioners, decision-makers, and other key members of the public . . ." (Stolz, 1983, p. 7), a goal the Wolf-Welsh Linkage Methodology seeks to achieve. It should be mentioned with regard to computer-assisted instruction, one of the problems has been that the results obtained in some studies were achieved by using faulty methodology and there was hesitancy to adopt such an innovation because of that (Oettinger, 1969).

Besides the complications involved in the social sciences, it is important to recognize that the targeted audience in education, usually teachers, lives in a complicated world, only part of which is teaching itself. Hewton's observation (1982) regarding college faculty describes this well:

> It is difficult to achieve a reasonable balance between the competing demands of research, teaching, and administration, and at the same time to maintain a satisfactory balance between work and leisure. Once an acceptable compromise is reached, it becomes a stabilizing factor. . . . creating a reluctance to disturb the balance (p. 84).

This dilemma manifests itself in situations where computer-assisted instruction is adopted, as an example. As the process is implemented, a change in the role of both student and teacher develops. For one thing, the student becomes a more active learner, thereby changing the traditional role of the teacher. The ensuing tension, if it occurs, can cause attitudes towards the innovation to turn negative. Over time, faculty might expect that money would be increased in one budget (equipment) with a corresponding decrease in the salary budget (Squires, 1982).

Resistance to Change

Watson (1969) has addressed resistance to change in a formal way describing twelve ways to reduce resistance:

1. Make adopters feel the project is their own.
2. Obtain support of top officials.
3. Demonstrate change as a way of reducing burdens.
4. Insure that the project is consistent with the values and ideals of adopters.

5. Describe the innovation in terms of a new experience.
6. Assure adopters that the innovation is not and should not be deemed as a threat to security or autonomy.
7. Have the participants agree on the basic problem.
8. Insure that adoption of the project is by group decision.
9. Ask that proponents of the project have empathy to opponents.
10. Build up trust and confidence over time.
11. Provide regular feedback to prevent misunderstandings.
12. Leave the project open-ended so that it can be modified as it progresses.

Many of these areas are incorporated into planned strategies which will be covered under that topic. They are also a main component of the Wolf-Welsh Linkage Methodology. Klein (1969) advocated resistance to change because such resistance serves to clarify problems with an innovation before it is adopted or implemented. When the problematic issues are raised and defined they can be addressed more thoroughly. Modifications can be made early in the implementation cycle which should contribute to the success of the innovation. Oettinger (1969) states that because of the interwovenness of education with society that ". . . any of the multitude of participants in the educational enterprise . . ." can preclude change by simply resisting it (p. 44). Others have created a model which identifies thirty-four discrepancies between the user and the requirements of a product; by categorizing the discrepancies into four categories ranging from "no problem" to "severe problem," the innovators can determine where the major resistance will be and use that information to rate market segments in terms of probability of adoption (Sikorski & Hutchins, 1974).

Strategies for Change

The inability to develop a cohesive paradigm for the diffusion of an innovation has its roots in the almost insurmountable mass of indicators with which innovators must deal. As stated previously, Rothman (1974) in a study of 921 research reports was able to develop 228 generalizations on planning and organizing for social change. Zaltman and Duncan (1977) offered 178 "principles" of planned social change while cautioning that the list was ". . . far from exhaustive" (p. 379).

Bhola (1984) has developed a systems approach model for change which is a function of four variables: Configurations, Linkage, Environment, and Resources. Optimization of these four variables would suggest an increase in the probability that an innovation will be successful. Others have developed lists of factors or characteristics related to successful innovation (Oettinger, 1969; Ostlund, 1974; Zaltman & Duncan, 1977). The number of factors range from nine to fifteen but differ in substance as well as terminology.

Havelock and Huberman (1977) have developed a classification of innovation strategies. They list five:

1. Participative problem solving - controlled by local people in response to their needs.
2. Open input - full flow of ideas from external and internal sources.
3. Power - laws, chain-of-command, designated agents.
4. Diffusion - the spreading of the innovation through informal opinion networks and the media.
5. Planned change - structured with careful planning, clear goals and objectives, and detailed analysis of the insiders' situation.

Although it appears that all of these would show up more or less frequently, it is interesting to note the preferences stated by various researchers as to the best strategy. Some prefer a grass-roots or local innovation strategy (Squires, 1982; Frazer & Nash, 1981; Hewton, 1984). Others emphasize the amount of money and the quality of support (Havelock & Benne, 1969); still others the necessity for a high level of involvement in the implementation phase of the project (Fidler & Johnson, 1982; Loucks-Horsley & Cox, 1984; Berman, 1980). In a producer-driven system as described by Peevely (1980), the great need for interpersonal communications is emphasized. Bhola (1984) expands the definition of power to include the power of knowledge, persuasion, and rewards and then states that it (power) is ". . . the essence of all strategy" (p. 11). Others, too, recognize that a power strategy can effect change (Squires, 1982). In contrast, some state that when users are allowed to enter the project voluntarily and leave the same way, the individual assumes a desirable sense of autonomy and control over the process (Schein, 1969). This approach, incidentally, was the one used by the PLATO group in working with the remote sites. Finally, there is a recognition that different strategies might be needed depending on the degree to which the target audience consists of self-renewers (Wolf, 1975), and whether the innovation is occurring during periods of economic recession or growth (Hewton, 1982).

Linkage Agents

The typical view of a diffusion system is one where the knowledge producer interfaces with the linkage agent who, in turn, interfaces with the target audience of user. The role of the linkage agent is similar to the commercial salesman and is considered a critical component in the diffusion process (Havelock & Havelock, 1973). The agents' roles consist of highly interpersonal communication between themselves and the knowledge producers and also between them and the knowledge users. Providing technical assistance to users and feedback to producers are usually vital constructs in planned change (Hood, 1982). However, it has been found that in social science practice the agents tend to diffuse to practitioners what other practitioners are doing rather than what the knowledge producers are doing (Zaltman & Duncan, 1977). This approach tends to create gaps between producers and users, weakening the dynamic necessary in getting new products into the hands of users or potential users. That and the insufficient number of capable agents to carry out the linkage role continue to be problems not easily solved (Spivak & Radnor, 1979; Hood & Cates, 1978).

Institutions to Aid Diffusion

K.R. Kelson, acting Assistant Director for Education at the National Science Foundation appeared before the House of Representatives Sub-committee on Science, Research, and Development on March 7, 1973 and stated that ". . . not very much is known about why it is so difficult to transfer knowledge from the research community to the educational system. And why it is so difficult to transfer new kinds of educational products from the development phase into its actual use." There have been major attempts to overcome those difficulties. The National Diffusion Network, started in 1974, was created to diffuse through the applicable segments of the educational system innovations implemented and proven to be effective through statistical analyses (Taylor, 1982). The Research/Development and Implementation system was initially created within the Office of Education and later transferred to a newly created institution, the National Institute of Education. While it, like the National Diffusion Network, hopes to diffuse innovations, the National Institute of Education also funds promising local innovations. Somewhat paradoxically, one of the early criticisms of the National Institute of Education was that it was not "linking" effectively with Congress which, in turn, created funding problems for the Institute

(Spivak & Radnor, 1979). One of the major functions of the National Institute of Education was the development of regional labs to draw on innovative research from universities, further develop the products and then diffuse them. Subsequent dissatisfaction with this approach has led to the reduction in the number of labs from 17 to 9 (Spivak & Radnor, 1979).

The Educational Products Information Exchange (EPIE) serves a different function. Its purpose is to evaluate educational products and in turn report its finding to the educational community.

The ERIC Document Reproduction Service stores articles on educational matters dating back to 1966. These articles can be searched on an on-line basis for possible applicability to a research project. Those articles of interest can then be researched in depth using inexpensive microfiche facilities located at many college libraries. Individual microfiche and hard copies can be obtained from the Service.

UNESCO has also established a dissemination function. Its International Educational Reporting Service (IERS) provides educational leaders with accounts of innovative work completed or underway.

Summary

This review of literature highlights the fact that the diffusion of an innovation is not a simple matter. There are a multitude of influences on social change, particularly educational change and there are a number of factors with which the researchers must content. In turn, there are a variety of strategies promulgated to effect change and a number of institutions created as conduits in the diffusion process. However, the review shows clearly that the literature is descriptive in nature. It provides interesting reading but is not concise enough or directive enough to assist an individual or group in effecting change nor is it in a format usable to laymen.

The study of PLATO described in this paper uses the cogent descriptive concepts concerning change theory as developed over time. The study then frames those concepts within the prescriptive constructs of the Wolf-Welsh Linkage Methodology and seeks to determine if the Methodology can be utilized as a tool to bring about change.

CHAPTER III

PROCEDURES

Introduction

The procedures used in this study are consistent with those in an ex post facto study. This chapter consists of a discussion of the data sources used to evaluate the Methodology, a section describing the PLATO project in some detail, a presentation of the linkage tool used to evaluate the project, and finally how the data was compiled and analyzed.

Data Sources

The procedures used to gather data began by searches of two data bases, the first being that maintained by the ERIC system. The three separate ERIC searches used educational innovation, computer-assisted instruction, computer-managed instruction, linking agents, PLATO, National Science Foundation, and National Institute of Education as key words in various combinations within certain time periods (e.g., after 1974 and before 1975). Abstracts were obtained and documents searched. A search was also made of and abstracts obtained from the ABI/INFORM data base managed by Data Courier of Louisville, Kentucky. This data base has a business orientation.

Key words used in the search were product and innovation. The 1986-87 Books in Print was searched for recent books on educational innovations and its derivative forms. The search was conducted by author and by subject headings.

The initial effort to obtain data on the University of Illinois PLATO system centered on obtaining a bibliography of PLATO articles. This was available in part in an on-line file on the UMASS PLATO system. More recent citations were obtained from the Computer-Based Education Research Lab at the University of Illinois.

A series of communications by letter and telephone was begun in the early part of 1986 and continued for almost a year. The communications were with various funding agencies which were thought to have supported the PLATO project during the 1972-1976 time period. Among the funding agencies contacted were:

1. The National Science Foundation
2. The National Institute for Education
3. The Fund for the Improvement of Post Secondary Education at the Department of Education
4. The Department of Education
5. The National Council for Adult Education
6. The Ford Foundation
7. The Kettering Foundation

Initial communications with Control Data Corporation were with a number of individuals including regional and national PLATO marketing representatives, PLATO marketing directors for industry, and J. Palmitessa, special assistant to W.C. Norris, Chairman Emeritus of the Board. In December of 1986, a telephone interview with Norris was conducted (Appendix B).

In addition to communications with the University of Illinois, requests for information were sent to both Florida State University and the University of Delaware. These were the second and third educational institutions in the United States to install stand-alone PLATO systems.

As information concerning valid sources of data was received, it was decided to make the following trips to gather data:

1. National Science Foundation, Washington, D.C. (May, 1986). The data of interest concerned the National Science Foundation contract covering the PLATO implementation and demonstration project, 1972-1976. The data reviewed on this day trip consisted of nine folders in a cardboard carton. Appropriate notes were taken. All other information had been stored in a warehouse in Virginia and could not practically be made available. Requests were made at that time for information on grants awarded to the University of Delaware for PLATO projects. These were forwarded at a later date.

2. Ford Foundation, New York City (August, 1986). The purpose of this day trip was to review the Ford Foundation grant made to the University of Illinois for PLATO development during the 1972-1976 time period. The file for the grant (PA 71-293) was on microfilm. Copies of relevant material were made.

3. University of Illinois, Urbana (October, 1986). The purpose of this week-long trip was to see the PLATO system, interview key people and search available files. The relevant files were stored in the basement of a house owned by the University of Illinois. A major portion of the time was spent searching these files. The Archivist of the University also provided additional sources of information.

Communication was also initiated and sustained with the Charles Babbage Institute for the History of Information Processing at the University of Minnesota. The institute has recently received a grant from the National Historical Publications and Records Commission to do a study of PLATO from a historical purview. It has expressed an interest in this study on the diffusion of PLATO.

The PLATO Project

The PLATO Project can be viewed coherently in four parts: as a product, prior to the 1972-1976 implementation and demonstration period, during the implementation and demonstration period, and following the implementation period. This orientation is offered to convey the complexity of the innovation and the magnitude of the implementation/demonstration initiative.

The period from 1972-1976 was significant in the history of the PLATO product in terms of its diffusion. By 1972, PLATO had been in use for approximately twelve years. However, for all intents and purposes, it was still a "local" product, confined to the University of Illinois and its environs. It had met with considerable success and was receiving ongoing support from the Illinois legislature and modest support from some funding agencies. However, it appears that without substantial increases in financial support, PLATO could not have made the "quantum leap" forward which was necessary for its diffusion. There was a need to upgrade the system software and to develop new demonstration sites which would allow the testing at different educational levels, particularly the community colleges for other than nursing education and the elementary schools. The infusion of money beginning in 1972 and ending in 1976 permitted the next logical step in the diffusion of an innovation and, at the end, an evaluation of its success.

The years 1972-1976 were a watershed for PLATO. At the end of the period, PLATO would probably be a success and ready for further diffusion or it would retrench to being a local product useful to the University of Illinois. The study focuses on an analysis of that period.

PLATO, the Product

It is important at the outset to define what PLATO is or has been. It initially was a concept of a computerized tutorial with feedback. As it evolved, it became a product which included an operating system, an authorizing language, and hardware (sold by Control Data Corporation). It also had as options plasma-terminals providing high quality graphics in a flicker-free mode, photographic slides, and audio disks. Some of the lesson software (courseware) written on PLATO included off-line instructional materials. By the 1972-1976 time period, it also had inter-terminal and telecommunications capability.

After the implementation and demonstration period, significant changes were made to PLATO. One version was developed to run on a network basis using microcomputers and minicomputers. In 1982, PLATO instruction was disassociated from unique (Control Data) hardware (Control Data Corporation, 1985). PLATO instruction is now available on IBM and Apple microcomputers as well as on the traditional mainframes and the later network processors. The University of Illinois has developed a new version of PLATO called Novanet, which it began marketing in December of 1986.

Pre-project Years

PLATO was a product developed at the Coordinated Science Lab, later known as the Computer-Based Education Research Lab, at the University of Illinois at Urbana. It has been since 1976 a trademark of Control Data Corporation, headquartered in Minneapolis, Minnesota. Initial systems design work on PLATO was completed in 1960. It was a one-terminal system programmed to provide feedback and with the ability to generate character on a cathode ray tube and also to incorporate photographic slides for presentation (University of Illinois, 1960). The processor was an ILLIAC I computer. By the early part of 1961, PLATO II was implemented. The system was used to teach a course in computer programming (Alpert, personal interview, October 31, 1986). This was a two-terminal system (Lyman, 1977). In 1962, Control Data Corporation delivered to the University of Illinois a CDC 1604 computer to which the PLATO project was given limited access (Control Data Corporation, 1985). PLATO III, with its capability to handle 32 terminals was installed in 1963; inter-terminal communications capabilities were completed in 1964, the same year the ability to use two different lessons simultaneously was implemented. The first authoring language, called Computer for Automatic Teaching Operations (CATO), came on line in 1965; in 1966, the PLATO project received its own CDC 1604 computer and, with it, direct support from Control Data Corporation; student use by that time was running about 8,000 hours per year (Lyman, 1977). In 1967, the Computer-Based Education Research Lab was formed for research on PLATO (Control Data Corporation, 1985) and the TUTOR authoring language, a successor to CATO, was first used (Lyman, 1977). The following year, the initial National Science Foundation grant for the development of a prototype PLATO IV touch terminal was awarded. In 1971, Control Data Corporation made a corporate contribution toward an advanced 6400 computer and, in turn, received rights to the research done on the system. Student contact hours were now running at an annual rate of over 20,000; the cumulative number of hours was up to 100,000 (Lyman, 1977).

Implementation and Demonstration Period, 1972-1976

The National Science Foundation contract (#NSF-6723) of five million dollars initially triggered the rapid development of PLATO as an on-line educational system with telecommunications capabilities and the potential to handle 4,000 terminals logging ten million student contact hours annually. During the last half of 1972, the number of terminals increased from 20 to 250. Terminals were in 40 different locations, 15 at the University of Illinois and the others off-campus at the various elementary school and community college sites. In addition to the financial support given by the University of Illinois and the National Science Foundation, support was also being provided by the Ford Foundation, Kettering Foundation and the Advanced Research Projects Agency of the Department of Defense.

By the fall of 1976, 900 PLATO terminals were installed at 140 sites which included 9 elementary schools, 6 high schools, six community colleges, twenty government-related installations, and thirty colleges and universities (National Science Foundation, 1976; Lyman, 1977).

Earlier in that year, the agreement between the University of Illinois and Control Data Corporation was signed and confirmed by the University's Board of Trustees (University of Illinois, 1976). This agreement gave Control Data exclusive rights to market PLATO software and courseware and to have first rights of refusal of any future courseware developed at the University. The agreement was for a period of five years, renewable for another five years.

Post-project Period

After the project period and the acquisition of the PLATO software and courseware by Control Data Corporation, the marketing of PLATO was, in large measure, an activity of Control Data Corporation notwithstanding the fact that businesses or institutions could continue to realize the same benefits by contracting for usage on the University of Illinois mainframe. By 1981, there were seventeen operational stand-alone systems, seven of which were in this country. The University of Illinois system served 200 sites from the Urbana campus.

Recent data show that, in addition to those systems at Control Data Corporation's own training institutes, there are 75 full PLATO systems in use, 50 of them in industry. Two hundred colleges and universities are connected to the various systems (Turner, 1984). This number of PLATO users is likely to increase as PLATO software is written for microcomputers.

PLATO has been expensive. F. Propst at the University of Illinois estimates that the total amount spent by the University and supporting agencies and corporations is about $59 million (personal interview, October 30, 1986). The cost incurred by Control Data Corporation is approximately $900 million (Turner, 1984), of which $13 million was for support at the University of Illinois (Propst, personal interview, October 30, 1986).

The Linkage Tools

The current version of the Wolf-Welsh Linkage Methodology (six revisions) is akin to a road map that specifies a starting point, alternative routes, and a destination. It adds order and direction to the knowledge diffusion and knowledge utilization processes within organizations not accustomed to either order or direction.

The Wolf-Welsh Linkage Methodology consists of seven distinct but interrelated parts. Each part is made up of two components: the first is a brief orientation statement intended to clarify the nature of information sought; the second is a set of recommendations aimed at acquiring needed information. Whereas the seven parts are presented sequentially, their interrelated nature calls for application of specific parts in conjunction with opportunities presented. These parts prescribe a relevant frame of reference within which individual ingenuity is encouraged and is able to flourish.

What accrues to persons who choose to incorporate the Wolf-Welsh Linkage Methodology as part of their linkage repertoire? First, these persons get the "big picture" and the "little picture" related to a change initiative quickly. Second, these persons are told what to do in order to make fruitful things happen within an environment earmarked for change. Third, these persons become the recipients of systematic feedback pertaining to the viability of specific plans made and specific action taken. And fourth, the Methodology facilitates the production of physical traces during a change initiative which can be studied to determine pluses and minuses of the effort (Wolf, 1987).

Parts of the Wolf-Welsh Linkage Methodology

I. Qualifying for Linkage Responsibility

II. Targeting an Audience for a Change Initiative

III. Defining Knowledge to be Adapted or Adopted

IV. Modifying Knowledge Selected to Accommodate Identified Needs of a Targeted Audience

V. Obtaining Commitments from Key Persons to Initiate and Sustain a Change Undertaking

VI. Conceptualizing and Implementing a Linkage Plan

VII. Ascertaining the Impact of Selected Knowledge upon a Targeted Audience

Perspectives obtained in this manner may have a profound impact upon the direction of a linkage initiative. The course of action defined may be confirmed, or the course of action defined may have to be modified or aborted because of what has been learned. It is possible to respond constructively to each of these options. For example, if confirmation occurs, the message encourages full speed ahead; if modification is indicated, the message suggests remedial action be taken to sustain momentum; if abortion is in order, the message focuses attention upon the preservation of available resources for utilization at a more opportune time. A coherent response is conceivable in each instance; it is up to the person or persons responsible for the linkage initiative to make an appropriate decision and then implement it.

Validation of the Wolf-Welsh Linkage Methodology has proven to be a most complex challenge. The validation process involves: (a) training persons to be able to implement the instrument; (b) locating an organizational context about to embark upon a change venture; (c) obtaining resources to facilitate work envisioned; and (d) evaluating both the instrument's implementation as well as consequences of the change initiative. All these conditions have been in place enough times to enable Wolf and his associates to stockpile a substantial reservoir of constructive feedback (Wolf, 1987).

Thus far, feedback has been offered as case study and/or anecdotal reports, which may or may not contain data manipulations. The reports focus upon consequences of field applications of the instrument, critiques of the instrument, and analyses of ex post facto applications of the instrument. Most information has been generated by the instrument developers and has not been confirmed independently, at least not yet. Steps have been taken to remedy this deficiency.

The instruments have been revised six times as a consequence of information obtained. The revisions brought under control the prolixness of the Methodology, improved relationships between specific elements of the theoretical configuration and specific elements of the tool, and increased the scope and flexibility of the methodology. One major problem remains to be resolved, namely, how to ascertain qualities of people who are most likely to utilize the instruments prudently.

Many persons associated with a variety of organizations can take credit for the feedback provided. Persons affiliated with projects funded by the Women's Educational Equity Act, by Title IVC of the Elementary and Secondary Education Act, by a state government, and by a municipal government, pilot tested both instruments; persons affiliated with a community college, a state education agency, and a non-profit research-oriented society, pilot tested one or more parts of both of the instruments; and, more than four dozen doctoral-level students critiqued one or both of the instruments. More than sixty individuals representing six different academic disciplines have contributed information intended to improve upon the instruments.

Compilation and Analysis of Data Obtained

The data generated from the various data sources as identified previously were, for the most part, in no usable order pertinent to the study. The Ford and Kettering Foundation files were in chronological order, but the National Science Foundation files were not. Many files at the University of Illinois were searched and generally there was a chronological order within topic. However, no files were of such a nature that they conformed to the steps of the methodology.

The assembled data consisted of copies of documents from the Ford and Kettering Foundation and notes made from documents at the National Science Foundation and the University of Illinois. All of the data was paginated, then analyzed and information potentially applicable to a specific step in the Methodology was identified. For example, a memo from the University of Illinois to the National Science Foundation might include information which would apply to more than one step of the Methodology. Other material not applicable to the steps in the Methodology but useful in understanding the background of the project was also identified.

The next step was to create note cards from the data identified as pertinent to steps in the Methodology or for background information. Each note card identified its applicability (Methodology step or background) and the original source. About 300 note cards were created in this way. After this process, the written analysis of the PLATO project began. Some cards previously identified as potentially useful were eliminated at this stage when it was determined that they would be redundant. An example of this would be the same document which showed up in two different data sources. Care was taken to insure that the data was allowed to "speak for itself" rather than to use data which fit the Methodology.

CHAPTER IV

PRESENTATION OF DATA

Introduction

In this chapter, each step of the Methodology is identified and a brief description of the step is presented. (The reader is referred to Appendix A if additional information on the step is needed.) The results of the data obtained are then given. A brief summary follows. After each step is treated in this manner, a summary of each step is provided in table form, identifying the degree to which the PLATO project implemented each step in the Methodology or if the step was not implemented. The chapter is constructed to permit the reader to scan the various summaries quickly or read the material in greater depth. A detailed reading of the chapter should give the reader an extensive amount of information concerning the many activities which occurred during the PLATO project.

I. Qualifying for Linkage Responsibility

The Methodology

This step in the Wolf-Welsh Linkage Methodology includes not only the qualifications of linkage agents but also the attributes believed to effect successful linkage. In evaluating the application of this step to the PLATO project, it is necessary to recognize that the project is multidimensional since it was not only those individuals at the University of Illinois who were involved in the linkage aspect of PLATO, but it was also those individuals at the funding agencies who were willing to support the grants and contracts with the University of Illinois. The funding agencies' roles are critical because the agencies provided the necessary funds and support which allowed the linkage to take place. It is therefore necessary to identify documents which support or reject this step in the methodology from two vantage points, from within and without the University of Illinois.

Results

D. Alpert, Director of the Coordinated Science Lab (later the Computer-Based Education Research Lab) at the University of Illinois and later Dean of its Graduate College, had come to Illinois from a career which included participation in the Manhattan Project, development of military radar components and research in ultrahigh vacuum technology (Alpert, personal interview, October 31, 1986). It was Alpert who selected Bitzer as the director of the PLATO project in 1959. His selection of Bitzer was based on the following:

1. Bitzer had hardware/system software knowledge.
2. He was motivated.
3. He had knowledge of the subject matter which was to be used in the initial pilot test of the PLATO system.

By the time the University was applying for the National Science Foundation and Ford Foundation funding, Bitzer and other key people had more than 10 years experience with PLATO. In 1972, the University of Illinois was able to state in a position paper entitled Long-range Plans for the Computer based Educational Research Lab that the PLATO project had ". . . achieved national and international recognition as the leading program in the development of [Computer-Based Education] and educational technology in general."

A. Knox was in charge of the development of the community college component of the PLATO project. He had extensive experience in the adult education field and was junior author of a work which addressed linkages between universities and surrounding communities (Farmer & Knox, 1977). Alpert (1972), in his memo to Knox, stated the necessity of making sure in the National Science Foundation proposal that Knox emphasized the uniqueness and motivation of the PLATO project group as well as familiarity with what other institutions were doing in computer-based education. The bibliography of the proposal had 180 references, including 39 works that Knox had co-authored.

R. Davis was initially coordinator for both the elementary mathematics and elementary reading programs, although his field of expertise was mathematics. (Later, a separate coordinator was appointed for reading.) Davis had directed a project designed to rethink and reshape mathematics curriculum and had substantial experience in introducing innovations (Swinton, Amarel & Morgan, 1979).

The recognition that people in the PLATO project had received allowed others seeking grants to use that recognition to support their own requests for other funding. Umpleby (1973) had included in his grant proposal to Kettering a supporting letter from Bitzer. Umpleby's three years of experience with the PLATO group was acknowledged at Kettering (Howell, 1973).

In its proposal to the National Science Foundation (1971), the University emphasized the following points in establishing its credibility to undertake the demonstration project:

1. Alpert and Bitzer had been involved with PLATO since 1959.
2. The Computer-Based Education Research Lab was a special unit within the Graduate College.
3. The Lab was a large organization.
4. Academics, not technicians, were writing the courseware.
5. No other organization had the amount of understanding and capability that the PLATO group had, almost forty man-years of effort.
6. The University of Illinois had already committed approximately $1,000,000 toward the development of PLATO.

An early Alpert letter (1969) to the Ford Foundation began by citing the long-term commitment the University of Illinois had already made to PLATO, but also that PLATO had attained a certain level of success. Attitudes of funding agency personnel and colleagues were generally supportive of the PLATO group. An anonymous Program Director at the National Science Foundation felt that the PLATO group was ". . . tiny . . ." but ". . . appears to be one of the best in the country." (1972).

Documents in the Ford Foundation files are descriptive in developing an understanding of how that agency looked at the PLATO group. M. Chamberlain, a program officer in the Division of Education and Research, found the following items of interest in analyzing the PLATO program (1970):

1. PLATO was centered in the Graduate School at the University of Illinois rather than in the School of Education.
2. Alpert was directly involved.
3. The University of Illinois had a strong tradition in the computer-based education field.
4. The PLATO group had the ability to disseminate knowledge of new techniques of instruction.

A year later, H. Howe II, Vice President at Ford, wrote to McG. Bundy, President, describing the grant (1971). He offered the following points in support of the University of Illinois as recommended grantee:

1. The University of Illinois had had significant experience in working with computer-based education; it had completed three software versions of PLATO.
2. There was breadth to their work; twenty fields of study at levels from elementary to graduate school had used PLATO.
3. Users of PLATO had accumulated over 100,000 contact hours.

4. Illinois had developed an authoring language, permitting people to write courseware without the necessity of learning a programming language.
5. They recognized that there was a need to bring down dramatically the cost of computer-based education.

R. Schrank of the Ford Foundation (1973) reported after a visit to the University of Illinois campus that the National Science Foundation contract with the University of Illinois was well placed since they had ". . . outstanding technicians as well as good curriculum people." He felt that, although the Ford grant was not renewable, the Foundation should maintain a continued interest on the part of other institutions such as the National Science Foundation. Schrank also was aware that Bitzer had received significant recognition, mentioning that Bitzer had received an award from the National Academy of Sciences for outstanding contribution in the field of applying electronics technology to learning. M. Dahl at Ford had visited the Illinois campus at an earlier date and commented (1971) that Bitzer was ". . . an imaginative, energetic, and attractive person, who clearly gives a dynamic leadership to the Laboratory."

The only evidence of doubt at the Ford Foundation about the PLATO activities at the University of Illinois came from M. Martus, a program officer. In memos to the files (1975, 1976), she expressed some reservations about PLATO. The reservations, described during the last part of the grant and after the grant was completed, centered around the following matters:

1. The National Science Foundation project was primarily a developmental pilot project although the intent initially was to make it a demonstration project.
2. The time frame was unrealistic.
3. There was a misunderstanding concerning the development of curriculum within a laboratory environment and its usability in actual teaching environments.
4. The individual hired for the reading portions of the Ford grant was not ". . . sufficiently knowledgeable . . ." in the reading area.
5. Cost estimates were not realistic. Early in the PLATO demonstration project, anticipated costs were as low as $.05 per hour for each student using PLATO; however, costs of using PLATO remained at $10 per hour.

With regard to his ability to meet deadlines, Bitzer had been recognized as one whose ". . . enthusiasm was known to spring forth sometimes in the form of outrageously optimistic timetables and predictions, but at times he seemed able to push back the edge of the impossible" (Kingery, Berg, & Schillniger, 1967).

It is also important to note that, since participation in the PLATO project was voluntary, those teachers and instructors who chose to work on the program could by and large be classified as innovators. Swinton et al. (1979) referred to the elementary school teachers as high innovators, "i.e., teachers who have a history of participating in new projects" (p. 3-12).

Within this step, the Methodology refers to people who act as bridges between knowledge producers and knowledge users. This ability to act as bridges between producers and users is facilitated in academe because of the ability of the population to move from one institution to another. The diffusion of PLATO was aided by the relocation of two people, L.L. Campbell and H. Carter.

Campbell, whose background was in bacteriology and microbiology (American Men and Women of Science, 1976), was Professor of Microbiology at the University of Illinois from 1962-1972, becoming Director of the School of Life Sciences in 1971. In those positions, he served on the Computer-Based Education Research Laboratory PLATO advisory board (L.L. Campbell, personal communication, July 25, 1986). In 1972, he became Provost and Vice President for Academic Affairs at the University of Delaware.

In the fall of 1974, the Computer Applications to Education Committee at Delaware deliberated the subject of computer-based education and the criteria for selection of a system (Hofstetter, 1986). Just prior to that, in July of 1974, a group of individuals from the University of Delaware, including Provost Campbell, attended a PLATO demonstration at Urbana (Local Demonstration File, 1974). In March of 1974, the first PLATO terminal was installed at Delaware (Hofstetter, 1986). When asked about his role as a change or linkage agent, Campbell (personal communication, July 25, 1986) stated that he had established the criteria for system selection. When the faculty committee made its recommendation to use PLATO as its educational computer system, they were requesting it ". . . of a person who was already knowledgeable of its potential to improve instruction." In this case, Campbell as a knowledge user at Illinois became a decision maker at Delaware.

A second, briefer example of linkage agents and movement within academe would be H. Carter, who, as Vice-Chancellor for Academic Affairs at the University of Illinois during the early days of PLATO, was a key figure in providing support. He was also chairman of the National Science Board. He later went on to the University of Arizona, where he became Provost. The University of Arizona subsequently became a PLATO user. (It, incidentally, was the first remote test site in 1986 for the University of Illinois Novanet System.)

Summary

In summary, the PLATO project as it existed at the beginning of the 1972-1976 time period was surrounded by skilled, creative and innovative people. People like Bitzer and Alpert had been leading the development for the entire period. The University of Illinois itself had supported the project with a substantial allocation of funds for hardware and staff. Key personnel at the funding agencies believed strongly that the attributes of the personnel at the University of Illinois warranted support for the "nationalization" of PLATO.

II. Targeting an Audience for a Change Initiative

The Methodology

The goal within this step of the Wolf-Welsh Linkage Methodology is to identify an audience appropriate for a change. Defining the parameters of that audience, identifying those who assume decision-maker responsibilities and identifying those who are opinion leaders within the audience are the items of interest.

Results

A review of documents obtained and interviews conducted shows not only the various audiences which PLATO could serve but also identifies key individuals who could influence the direction PLATO took. Alpert, at an early date, had regarded computer-based education as a "new approach to education . . ." (1960) but simultaneously recognized that the initial effort had to be more narrowly defined. This prompted him to direct the initial effort toward using the computer to teach a programming course (Alpert, personal interview, October 31, 1986). After a decade of the development of PLATO, Alpert was ready to identify a broad, if not all-encompassing audience toward which PLATO could be directed. Although his comments to F.C. Ward at the Ford Foundation (1969) defined a radius of 150 miles as the area in which PLATO would operate because of communication limitations, he proffered at the same time a sense that the PLATO demonstration project would have ". . . far-reaching educational impact." He expanded that theme in a subsequent letter to Ward (1969) where he stated that the PLATO innovation provided a ". . . major opportunity to increase educational productivity, not solely to enrich or add new features to what we are already doing." In writing to H. Howe II, also a Vice President at Ford Foundation, he had stated that in his view, "PLATO can make the difference in whether or not education meets the changing needs of society for more and better education, in varied locations and situations, for people of all ages" (Alpert, 1972a). That same year, Alpert repeated what he saw as the scope or targeted audience when he told H. Stever, a director at the National Science Foundation, that PLATO could have ". . . a revolutionary impact on the entire 60 billion dollar education establishment . . ." (Alpert, 1972b).

Bitzer's view of the potential targeted audience was colored somewhat by the costs involved in PLATO. He felt (Kingery et al., 1967) that the then existing high costs would dim any enthusiasm for funding PLATO in the public schools; rather he felt that it would probably first find acceptance in the home in a variety of uses.

By the time the University of Illinois made its proposal to the Ford Foundation, it had used PLATO to teach students from the preschool to the graduate level. However, the proposal to the Kettering Foundation (Grant-in-Aid, 1973) focused not on its instructional potential but rather on the communications capability of PLATO and its potential to serve as a medium for citizen involvement in community processes, an interest at Kettering at that time. Howell at Kettering (1973) believed such a communication system which was able to aid in citizen involvement had international potential.

List at the Ford Foundation (1970) felt that there were ". . . any number of educational areas . . ." in which PLATO had potential utility. Schrank, also at the Ford Foundation, saw many areas in which he thought PLATO should be tested to ascertain its capabilities, among them ". . . a Jobs Corps camp, a MDTA (Manpower Development Training Act) program, a Southern or Indian manpower program . . ." and that a prison might be an ideal environment within which to test PLATO (1973). Interestingly, a lot of basic skills work has since been done in prisons using PLATO. Chamberlain (1970), also at Ford Foundation, was aware of PLATO's generic and non-specific nature. A National Science Foundation report (1971) cited the promise of computer-assisted instruction to education but what was restricting or retarding the use of computer-assisted instruction was that the ". . . effective instructional domain of application of CAI is not clear, nor its boundaries with traditional instruction." This was partly the reason the National Science Foundation was willing to commit the initial funding of over five million dollars for the demonstration phase of ". . . this very promising educational system" (Kenefick, 1973). McWilliams, also at the National Science Foundation, felt that the PLATO demonstration project would most likely have a ". . . strong influence over the course of education - especially computer based - over at least the next ten years" (1972).

Military organizations picked up on the capabilities of PLATO as a training delivery system. Chanute Air Force Base in Illinois had been a user of PLATO for a couple of years and, in 1974 (TTOE) reported that, predicated on the experience gained at the Air Force Base, PLATO had ". . . great potential . . ." for both instructional and administrative training as well as to cut overhead costs in providing didactic education while leaving specific Air Force training to military instructors. A Brigadier General assigned to the Office of the Chief of Staff (Fair, 1971) concurred in this assessment.

Norris, Chief Executive Officer at Control Data Corporation, had a longstanding interest in computer-based education going back to the post-World War II Link Trainers which provided on-the-ground simulation of flight training. He believed that PLATO's greatest potential was in industrial training, since PLATO could deliver education and training at a lower cost than traditional methods and that industry, with its need to satisfy the "bottom-line," would give PLATO a warmer reception than education, which did not have such requirements (1986). Turner, writing much later (1984), stated that Control Data was trying to market PLATO to the audience for which it was originally intended, higher education. But this statement is not supported by the above references. Indeed, Norris at Control Data, who has shepherded that company's PLATO activities, did not view PLATO's potential audience as higher education.

Summary

In summary, the magnetism of PLATO was not its specificity; rather it was its generalizability, its ability to serve any goal (Oettinger, 1969). It was a delivery system, in effect a vehicle to deliver computer-assisted instruction. Within these guidelines, it could be whatever the educator or communicator wanted it to be. It is clear that many key personnel had different audiences in mind when they looked at PLATO. Although the implementation and demonstration project had specific audiences in mind, the potential for PLATO as a computer-assisted instruction system really had no parameters.

III. Defining Knowledge to be Adapted or Adopted

The Methodology

Step III of the Methodology consists of three parts; first, the identification of a target audience's needs; second, the identification of products, practices, and ideas apt to meet the needs of the audience; third, the selection of practices, products, and ideas apt to meet those needs. The use of this step of the Methodology in an *ex post facto* study creates a dilemma since the product selection is a *fait accompli* at the outset. The approach, therefore, must be to identify some of the reasons for the selection of PLATO after a discussion of the target audience's needs and identification of products, etc., apt to meet those needs. However, target audiences' needs are frequently defined by opinion leaders (funding agencies, educational leaders) rather than the users of the product (teachers and students).

Results

Zaltman and Duncan (1977) define need in terms of a performance gap when they say it ". . . is a discrepancy between the criteria of satisfaction in performing some act and the actual performance of the act. The individual, group or organization simply feels that it ought to be doing better in its performance than it actually is. The performance gap thus serves as a stimulus to search for alternate ways of responding" (p. 24). Alpert and Bitzer (1970) identified what they considered to be needs of education in terms of quality and quantity. They cited the need to provide "more education over a larger fraction of the human life-span . . ." and ". . . more individualized instruction tailored to the specific preparation and motivation of a given student" (p. 1582). These unmet needs were defined when the University of Illinois made its PLATO proposal to the Ford Foundation (1970). The proposal highlighted specific needs at the various levels of education. In addressing higher education, the proposal stated that ". . . students and faculty alike perceive the urgent need for breaking out of the lock-step of required courses, the limitations of the large, impersonal lecture hall" (p. 7). This was an argument similar to that made by B.F. Skinner (1968) when he responded to critics of his programmed instruction methodology. In its proposal to the National Science Foundation, the University of Illinois mentioned a need for an inexpensive "facility" (1971).

At the community college, the National Science Foundation proposal addressed a different set of needs, specifically for qualified teacher faculty in such fields as computer science, mathematics, language skills, and life sciences. It also recognized that substantial remedial work was necessary at that level.

When the proposal discussed elementary and secondary education, it highlighted the need for individualized and supplemental instructions at the elementary level due to the problem of large numbers of functionally illiterate children, particularly in the inner city schools. It held out the hope that substantial improvement was possible. The Ford Foundation internal report recommending the awarding of the grant to the University of Illinois mentioned the needs of public education in terms of problems that had to be addressed and needs which had to be met (Howe, 1971). The specific items were:

1. The ". . . spiraling upward costs of education must be broken" (p. 1).
2. Students have learning needs which are individual in nature. These must be met.
3. There is a need to find ways to improve the management and financing of education; that is to increase the effectiveness and efficiency of education.
4. Teachers need to be increasingly involved in the planning and delivery of instruction.

5. There is a need to improve curricular content, especially for disadvantaged children.

The identification of possible products to meet the described needs focused on the computer as the logical device. The typical computer of the early 1970s was of a third or fourth generation indicating its maturity as a product. Auxiliary storage in the form of disk and tape allowed retention of vast amounts of data; with disk came the added advantage of rapid reading and writing of data. Internal or main memory speeds together with the development of software able to serve multi-users in a multi-tasking environment allowed rapid response to inquiries. When matched against the perceived needs of education, the computer seemed a good "fit."

The characteristics of the computer seemed a natural for didactic types of instruction such as tutorial and drill-and-practice. Rapid feedback and branching were simply variations of if-then-else computer logic control structures. The computer's ability to patiently continue the educational rigor provided students with the opportunity to continue working until mastery of the material was achieved.

Bork, at the University of California at Irvine, was one of the pioneers of computer-assisted instruction. In his early years in working with that process, he developed the conviction ". . . that the computer was eventually going to become the dominant delivery system in education" (1985, p. x). A National Science Foundation document (1971) identified the computer as having solid promise as a solution to pressures in education for ". . . higher quality and quantity, and greater variety, all at lower cost . . .". The proposal from the University of Illinois to the National Science Foundation (1971) emphasized the same theme. To the Ford Foundation, it mentioned the unique ability of the computer to handle didactic instruction on an individualized basis. Staff at the Ford Foundation, in its recommendation to fund the University of Illinois proposal, expressed some of the same ideas and included as desirable that the student was able to control the learning environment (Schrank, 1973) and held out the possibility that the computer could be used as an evaluation tool to build curriculum and to develop critical thinking skills (Howe, 1971), the latter an area that Papert (1980) was exploiting. Advances in artificial intelligence, expert systems and decision-making systems further pushed the computer into the position of being a ubiquitous system for educational purposes.

In 1972, the University of Illinois was one of a number of institutions using some form of computerized instruction. A PLATO Evaluation Note (1972) indicates the number of computer-based education centers and the academic areas covered. Chamberlain at Ford was pleased that the PLATO group was cognizant of other work being done in computer-assisted instruction (1970). McWilliams (1974) urged the PLATO people to visit other computer-assisted instruction sites. The Evaluation Note showed that there were 137 computer-based education centers in the United States. However, only 38 of that number had more than twenty hours of courseware in a given area, 14 had courseware in two or more areas and only six in three or more areas. Those six centers, the number of areas with developed courseware, and the total hours of courseware which had been written were as follows:

Center	Areas	Hours
University of Illinois	11	912
Philadelphia School District	7	1065
Florida State University	5	412
Stanford	3	308
Watson Research Center, IBM	3	236
University of Texas	3	116

These institutions were all establishing computer-based education as a tool to meet the various needs of education. It is interesting to note that Florida State University was later to become the second university to own a PLATO system; the University of Texas worked with Brigham Young University to develop a minicomputer-based educational system called TICCIT. (Like PLATO, TICCIT's development during the 1972-1976 time period was given substantial funding by the National Science Foundation.) In any case, the exposure of many people to computer-based education was establishing the fact that PLATO, as well as others, might be compatible with existing teaching practices. Sherwin, Associate Director of the lab to be known later as the Computer-Based Education Research Lab at the University of Illinois, and credited with asking the critical question of how could a computer be applied to education (Kingery et al., 1967), had envisioned the computer functioning muck like a textbook, but with feedback (Alpert, 1986). Although much courseware of different types had been written (simulation, drill and practice, for example), there was a substantial amount which was tutorial in nature, validating the textbook metaphor. Propst (1986), an Associate Director at the Computer-based Education Research Lab, has stated that he felt that PLATO's success was due largely to the fact that it was not a radical concept; rather, it addressed the problem of meeting educational needs in a way that would not have a critical impact on existing practices. It would fit within the paradigm of education.

PLATO can be defined in various ways. For example, W. Norris at Control Data Corporation (personal interview, December 29, 1986) defines it in terms similar to the definition of educational technology. This would include within PLATO such devices as overhead projector, film or slides. However, for the purposes of this study, PLATO is defined as a computer-oriented instructional system. It includes at the minimum a computer with disk storage and terminals with graphic capabilities as well as systems software, an authoring language and courseware. It can, depending on the strategy chosen to deliver the instruction, include any or all of the following:

1. Off-line curricular materials
2. Slides under control of the system software
3. Audio devices (disk and/or voice)

There are a number of factors contributing to the selection of PLATO as the vehicle for the large demonstration project under the

National Science Foundation contract and the Ford and Kettering Foundations funds. A list of the factors that played a part in the selection of PLATO would include what has been covered in Step I concerning the linkage agents. Other factors are:

1. The University of Illinois had worked in the past under a contract with the National Science Foundation so the Foundation was aware of what had already transpired in PLATO development.
2. In 1971, a demonstration of the PLATO plasma panel was held in Washington. Swinton et al. (1979) said the demonstration ". . . generated interest and funding from the National Science Foundation, the Advanced Research Projects Agency, and the University, to build and demonstrate an operational PLATO system" (p. 2-2).
3. PLATO III was able to handle 50 terminals. Increasing that to an estimated 4000 terminals did not seem an unreasonable extension of its capabilities.
4. The predicted cost of PLATO IV was one-tenth of the cost of PLATO III. This was attractive to those who felt that excessive cost was the one problem that had to be solved before computer-assisted instruction could be diffused throughout the levels of education (List, 1970; Oettinger, 1969).

5. Much of the PLATO courseware had been written by users. The aspect of further development of courseware by users was attractive (List, 1970).
6. PLATO was the only large-scale computer-assisted instruction system in operation at the time (Alpert, personal interview, October 31, 1986). McWilliams (1971) at the National Science Foundation was aware that a large-scale project was necessary to determine if computer-assisted instruction merited support and interest.
7. PLATO had graphics capabilities and the software to do the graphics.
8. PLATO had a tested nucleus of an authoring language (TUTOR).
9. PLATO, as a centralized system, could also serve as a communication device for and among users.

Summary

In summary, it can be said that there were expressed but unmet needs at all levels of education and those needs became pressing. Work of varying degrees was being done at a number of computer-assisted instruction centers and as the computer increased in speed and storage capacity, it became a logical choice of education to determine if it could meet some of the needs of education. The selection of PLATO for the large-scale demonstration project was the recognition that it was the one computer-assisted instruction system which was positioned in such a way that it could be reasonably expected to fulfill the goals of the funding agencies.

IV. Modifying Knowledge Selected to Accommodate Identified Needs of a Targeted Audience

The Methodology

When the PLATO project is viewed in the light of Step IV of the Methodology, a number of factors have bearing. The Step focuses on the ability to tailor the selected product to ". . . enhance compatibility with current practice; to facilitate adaption or adoption; to be in tune with available resource potential."

Results

During the 1972-1976 time period which is under scrutiny, PLATO had already developed some history. It was now a mature concept if not a mature product, having been in use for over a decade. It had been used at various levels of education from pre-school to graduate school. Its development was heavily dependent on feedback from earlier work. While the focal point of PLATO activity was at the University of Illinois, work had also taken place at remote sites such as the Urbana Washington Elementary School, affiliated with the University of Illinois, the Mercy Hospital School of Nursing and Parkland Community College. Mercy Hospital and Parkland Community College were also in the Urbana-Champaign area.

A brief look at the computer-based education for nurses developed at Mercy Hospital and Parkland Community College provides some insight into the capabilities PLATO was able to offer. The work at Mercy Hospital and Parkland Community College in computer-based instruction of nurses took place during the period September 1, 1966 - August 31, 1970. The project was supported by Project Grant NPG-188 of the Public Health Service, U.S. Department of Health, Education, and Welfare. The final report (Bitzer, Boudreaux, & Avner, 1973) describes the development and results of the project. (The project director was M.D. Bitzer, married to D.L. Bitzer, director of the Computer-Based Education Research Lab.)

The courses developed were for maternity nursing and pharmacology; instructional delivery techniques included both tutorial and inquiry pedagogies. Graphics, simulations, slides and immediate feedback were integral parts of the delivery process. The population exposed to the maternity course was close to 200 nursing students; the pharmacology course, although developed, was never implemented during the grant period.

Citing shortages of nurses, changes in technology, and the changes in roles and skills of nurses, the PLATO group through the hospital project sought to solve these problems. Any solutions would be expected to have value in other educational domains although course content would be different. By simulating clinical situations, mistakes in judgment by a student nurse would not ". . . result in trauma, emotional or physical, to either student or patient" (p. 3). As part of the project developed at Mercy, a computer-managed instruction component was developed. This component has been a key factor in providing an extensive record-keeping facility.

Some of the goals of the project were to determine if computer-based education could be effective in instructing nursing students, if the computer-based education could be integrated into the curriculum, if a relationship exists between learning and the problem-solving ability of the student, and if there are relationships in a self-directed learning situation between process variables and achievement. During the second year of the study, a control group for the maternity nursing course was created. The experimental group used PLATO exclusively; the control group received traditional instruction.

The teaching strategies used in the project were such that they could be adapted to almost any learning situation. They were:

1. Allow maximum control by the student including taking the initiative in how the learning activity will be accomplished.
2. Develop skills in the management of data (sorting, organizing, etc.).
3. Allow the student to respond to questions in a natural language. This necessitated the use of programming multiple responses acceptable in an open-ended question format.
4. Determine the best media use for the specific objectives. That is, if other media (film or discussion, for example)

were deemed to be superior, it or they were used instead of PLATO.

The nursing project at Mercy and Parkland, as stated above, allowed PLATO during the 1972-1976 period to receive and respond to some of the feedback it was getting from users, key persons in the modifying of courseware. For instance, the record-management function at Mercy Hospital and Parkland Community College provided detailed information as to what the students were accomplishing, how well and how quickly. Immediate feedback on students' responses to questions allowed the project group to revise unclear questions, to alter lessons, to add help sequences, and to add additional acceptable answers in open-ended questions.

In addition, the courseware provided the ability to log on-line exactly what the student was doing. During the course of a lesson, the following information was obtained and filed for analysis:

1. Total time in lesson broken down into the following categories:
    a. Main sequence
    b. Investigate mode (additional relevant information)
    c. Dictionary
    d. Help
    e. Data
    f. Comments

2. Number of specific requests broken down into the following categories:

    a. Investigation

    b. Dictionary

    c. Help

    d. Data

The results of the nursing project which were available prior to the commencement of the PLATO demonstration project supported the PLATO group's contention that computer-based education within the PLATO framework had merit. Time-on-task to learn the material was less and there was no reduction in performance compared to the control groups. All students who subsequently took State Board Examinations in Illinois successfully passed Obstetric Nursing.

A second example of feedback which had already been obtained by the time the PLATO demonstration project began in 1972 had to do with University of Illinois students' reaction to PLATO. A report entitled Student Attitudes toward PLATO, Survey Results (1972) mentioned two areas of criticism of PLATO: first, that it was an expensive "gimmick," and second, that the process of using a computer was dehumanizing. The Computer-Based Education Research Lab asked students (n=373) who had taken one or more courses using PLATO if they thought it was an expensive gimmick (87.7% disagreed or disagreed strongly), if they thought it was dehumanizing (78.8% disagreed or disagreed strongly) and lastly, how they would advise another student who had a choice in taking a course which either used PLATO for some of the delivery or did not use PLATO at all (74.7% said they would advise another student to take the PLATO section if at all possible or to ". . . fight tooth and nail . . ." for a PLATO section). Arsenty and Kieffer (1971) have reported on a small study which indicated PLATO had the potential to increase comprehension, stimulate active participation, reduce the time to learn and increase performance on tests.

A third example of evaluating the capabilities of PLATO prior to its National Science Foundation and Ford Foundation fundings in 1972 is to look at what had been published prior to that year. This provides insight into the audience to which the PLATO group had been exposed, in terms of number of articles published, the orientation of the publications, and the subject matter.

The Computer-Based Education Research Lab maintains an on-line bibliography of PLATO articles. It also periodically publishes the bibliography in hard copy. A recent issue (Lyman & Postlewait, 1983) shows the number of articles published each year, including those published by the University of Illinois. The annual figures for number of publications for the period 1961-1972 show the following:

Year	Number of Articles
1961	3
1962	5
1963	3
1964	7
1965	6
1966	8
1967	16
1968	23
1969	15
1970	30
1971	36

A sample of journals or agencies publishing PLATO articles includes:

1. U.S. Office of Education
2. National Education Association
3. IRE Transactions on Education
4. Phi Delta Kappan
5. Nursing Research
6. Journal of Educational Psychology
7. Audiovisual Instruction
8. Automated Education Newsletter
9. International Journal of Electrical Engineering Education
10. Automated Educational System
11. IFFF Transaction on Human Factors in Electronics

12. New York State Federation of Foreign Language Teachers Bulletin
13. Illinois School Board Journal
14. The Instructor
15. Journal of Engineering Education
16. Science
17. Journal of Chemistry Education
18. Educational Technology
19. Arithmetic Teacher
20. American Journal of Physics
21. Foreign Language Annals

Some of the academic specialties or topics discussed were the Russian alphabet, nursing, mathematics, computer programming, library use, national language mediation, medical education, geometry, organic chemistry, population dynamics, Latin, inorganic qualitative analysis, electrical network theory, compositions, political science, biology, and astronomy.

Before proceeding with the main thrust of the significance of Step IV in the Methodology, it is necessary to make a distinction between kinds of compatibility. Having developed the question of compatibility of PLATO with teaching practices, it is necessary to mention compatibility of the various operating system levels of PLATO thus leading into the discussion of the ease with which PLATO could be adopted.

A critical issue with any centralized system (the projection in 1972 was for 4000 users hooked up to the University of Illinois system) is how changes in operating system software and courseware would be managed. Updates of operating system software, if not done correctly and in a minimum amount of time, had the potential of creating major difficulties for users as computer-based education began to assume more of the time students spent at learning tasks. The PLATO group effected the compatibility of the Version III operating system with the Version IV operating system by making III a subset of IV. In effect, IV ran III and its associated courseware as if III were itself a piece of courseware. Although traditionally this approach tends to slow down the execution of programs, there is nothing in the PLATO documents to suggest that such a slow-down was noticeable; the conversion was "transparent" to the users. M. Johnson at the Computer-Based Education Research Lab (1973) mentioned this compatibility in a memo to the Advanced Research Projects Agency at the Defense Department. He stated that not only did this approach to conversion from PLATO III to PLATO IV eliminate any impact on users, but also that when the PLATO group had to go in and take the central machine for software and courseware updates, they were taking it for only three-minute time periods and were taking those three minutes between five before the hour and the hour since that was thought to be the time when classes would be changing and use of the system would be minimal. The University of Illinois proposal to the Ford Foundation (1973) reiterated this point; even extending it to say that PLATO IV would be ". . . compatible with regard to the use of materials developed for any other system" (p. 1). This, however, never turned out to be the case; even today, programs of courseware written under different operating systems are typically incompatible one with the other.

Another factor allowing PLATO to be adopted easily was the centralization of the processing capability. Historically, the entire computer industry has gone through phases from decentralized to centralized to distributed processing. During the 1972-1976 period, centralized processing was the common processing mode, which was the approach taken with PLATO. When the centralized mode of processing is adopted, it provides remote users with the assurance that the onus of keeping the system running, upgrading hardware and software, and managing the monitoring of telecommunications processes rests with the central processor site. This relieves remote sites of certain responsibilities including costs associated with hiring skilled people to overlook, manage and develop the necessary activities as would be the case with decentralized and, to a lesser extent, distributed processing.

The centralization of the PLATO system also had a direct effect on what it cost to do something with PLATO at a remote site. All that was required was a terminal (later the alternative of a microcomputer was offered) and a telephone hookup with modem. The fixed costs would be only about $5,500 for equipment and $250 per month for connection to the PLATO system. Dial-up capabilities would be a variable cost depending on amount of time connected, time of day or week the terminal was used, and distance. Assuming a life expectancy of five years for the equipment and annual maintenance costs of 10% of original equipment value, the annual cost would be:

Equipment $5,500/5	= $1100
Maintenance	= 550
Terminal connection (10 mos.)	= 2500
	$4150

Although such a configuration would not provide a lot of use, it did provide a remote site with the ability to assess the capability and utility of PLATO over an extended period of time. After a trial period, additional terminals and hookups could be funded or the evaluation discontinued. The "pay-as-you-go" philosophy permitted remote users to respond to increased demand without incurring substantial initial costs.

Costs were very much on the mind of those working with or funding PLATO. Alpert (1969) had held out the possibility of lowering the costs of PLATO under Version IV by a factor of ten, to $.50 per hour of connect time. Chamberlain at Ford Foundation (1970) mentioned this factor as well and indicated that such a reduction would make PLATO a viable educational instructional system. W. Bolton at National Science Foundation (1970), while addressing the issue that studies on the effectiveness of computer-based education were limited in scope as well as unconvincing, but generally favorable, also referred to the anticipation that costs could be reduced by a factor of ten.

Another factor was the ease with which potential adopters could commence using the capabilities either in using courseware written by others or developing their own courseware. List, of the Ford Foundation, stated (1970) that while on a site visit to the University of Illinois, she was encouraged to see professors ". . . of all ages . . ." developing their own courseware and demonstrating an ability to use the system with ease. The proposal to the Ford Foundation later that year emphasized the same point of user-friendliness, stating that the use of an authoring language (TUTOR) provided non-programmers with the opportunity to develop their own teaching strategies. TUTOR as an authoring language would be classified as very high level and would permit the author to develop courseware in such a way that system software and hardware considerations become trivial to the user. Chamberlain, at the Ford Foundation, pointed out that only a few hours of training was necessary before a user became productive using TUTOR (1970).

Another capability PLATO provided as a resource to users was technical support in using existing and developing new courseware on a dynamic basis. The ability to "talk" screen-to-screen allowed a user when in difficulty the ability to see who at the central site was on-line at the moment and initiate a screen-to-screen conversation. Also, the central site could, at anytime, log into the user's activity and monitor whatever process was causing difficulty or confusion. Should help not be available immediately, the user could frame the necessary question or questions and leave a message using the electronic mail facility. The central site could respond when a support person was available. These features certainly lessened the fear users might develop of having to "go it alone" although some (Knox, 1972) felt that central site support was at times inadequate.

There is a reasonable amount of information available for a discussion of pilot test sites during the 1972-1976 demonstration period. Such information provides insights into the approach agreed upon and the opportunity to see its compatibility to the pilot test component of Step IV of the Methodology. A series of memos and letters written in September of 1972 addresses the issue of proper site selection. Knox, in charge of the community college program wrote to Propst (1972) defining what he felt should be the criteria for selection of the community college sites (1972). He listed four:

1. Sufficient proximity to the Urbana campus.
2. Sufficient population to generate data for evaluation.
3. Sufficient commitment by key people at the institution.
4. Sufficient diversity of the student body so that it would approximate a typical community college.

Propst (1972) apparently agreed with this set of criteria since he passed the sense of Knox's letter on to McWilliams at the National Science Foundation. Shortly thereafter, McWilliams (1972) wrote to Propst concerning site selection. He wrote: "This demonstration seems certain to exercise a strong influence over the course of education - especially computer-based - over at least the next ten years," and that ". . . although it is experimental, it is not just another experiment, and every reasonable effort must be made that the demonstration moves education ahead and not back."

McWilliams urged the avoidance of "troublesome" sites, apparently referring to an experimental community college in the Chicago area (Propst, 1972). At the end of September, McWilliams responded to the question of site selection for the community college program. He stated that he felt two criteria were significant for site selection. First, that administrative and instructional conditions be of such a nature to permit a ". . . stable and productive . . ." program; second, that the faculty at the demonstration sites be committed to the objectives of the project. He wanted personnel at the sites to be aware of the national importance of what would be occurring.

Some of the other feedback which was available prior to or during the early stages of the PLATO implementation and demonstration project suggest the variety of people who were involved in the monitoring of the project. Not all were positive about the project: one director at the Ford Foundation who was mentioned in Step I as critical of PLATO at the end of the project provided negative feedback even before the Ford Foundation grant was awarded (Martus, 1970). This individual expressed areas of her concern and doubts that the Ford Foundation should support PLATO citing the following reasons:

1. The demonstration she had seen did not impress her; the system broke down frequently and the students' reaction to PLATO did not seem very impressive.
2. The proposal to the Ford Foundation was ". . . presented as an alternative to an ineffective teacher."
3. PLATO was not compared to other computer-assisted instruction systems in terms of its effectiveness.

The Ford Foundation grant did include an evaluation feature so that courseware content could be continually improved. Spargenburg, at Ford, expressed a need to determine whether the courseware materials were testing what they were supposed to test and teaching what they were supposed to teach (1973). Schrank (1973), also at Ford, wrote that he felt that the PLATO group was not getting enough feedback from disadvantaged and minority groups.

The Kettering Foundation proposal also had provision for feedback within its sphere of development. The work being done under the grant at the University of Illinois emphasized the communication aspects of PLATO, as distinct from the aspect of educational delivery. One of the products committed to under that grant was people's reactions to the citizen involvement programs (Umpleby, 1973). The proposal to Kettering mentioned specifically modifying PLATO to accommodate other needs (Howell, 1973).

One document which addressed feedback in a unique way was written by G. Jabker (1973) at Illinois State University concerning the difficulties of remote site users. He listed some areas of concern, not with PLATO per se, but rather with the administration of it. After citing the difficulty in getting PLATO terminals installed at Illinois State University, he commented thusly:

1. Programs written for students at other colleges might not be applicable to Illinois State University students.
2. Potential courseware authors at Illinois State do not want to develop the courseware unless there Illinois State University was willing to make a long-term commitment to PLATO.
3. If faculty at Illinois State do develop courseware, is there a need to develop a reward system for such authors?
4. If PLATO is used only as an enrichment activity, the cost of instruction is obviously increased.
5. On the other hand, if PLATO instruction is a substitute for faculty instruction, what is the faculty expected to do with the free time?
6. Some of the courseware already available on the PLATO system is extensive, amounting to hundreds of hours of material. In order to use existing courseware, adopting faculty would have to go through the entire courseware to determine its usability.

A final comment is necessary before summarizing Step IV. PLATO, as has been said, was a delivery system. When modifications were made, they were made to (a) accommodate hardware changes, (b) accommodate system software updates, or (c) accommodate changes in courseware. However, according to Bitzer (personal interview, October 27, 1986), any change in concept was really only an expansion of definition and adaptations to technological change.

Summary

In summary, PLATO was not developed in the stereotypical laboratory environment. Prior to the 1972-1976 period being studied, it had had substantial testing in areas similar to those developed during the project period. Consultants, instructors, funding agencies, and students all contributed to an effective broad-based feedback activity during the implementation and demonstration period. Its capability as an on-line and centralized system facilitated its adoption and modification during the test period.

V. Obtaining Commitments from Key People to Initiate and Sustain a Change Undertaking

The Methodology

This step of the Methodology focuses on determining the attitudes of people and obtaining commitments from key people to support the change or innovation. It includes a component whereby the change initiative can be discontinued if opposition to the change persists even after efforts at remediation are made.

Results

There is within the PLATO implementation and demonstration project a large number of key people whose attitudes toward the objectives of PLATO had to be considered. These would include the Governor of the state of Illinois, who, as a member of the Board of

Trustees, voted on the annual budget for the University, the state legislature, the administration at the University of Illinois, faculty and administrators at the remote test sites, consultants, and, last but not least, directors and program officers at the funding agencies.

E. McWilliams, at the National Science Foundation, prior to the contract with the University of Illinois had mentioned (1971) to D. Bitzer that the National Science Foundation had made arrangements for six individuals to consult for the Foundation in the area of demonstrations and evaluations of proposed computer-assisted instruction systems. The consultants were from Stanford University, Illinois Institute of Technology, University of Oregon, Dartmouth College, University of Texas, and Carnegie-Mellon University. (The Ford Foundation, at that time, was funding some computer-assisted instruction research at Carnegie-Mellon.) This arrangement gave McWilliams and the National Science Foundation feedback from knowledgeable people, which created a feedback link to the PLATO group. This link also provided an illustration of what happens when the progress of an innovation is unsatisfactory to key people.

The specific issue which caused concern at the National Science Foundation and at the University of Illinois was courseware of questionable quality. While the hardware configuration, the system software (PLATO IV) and the authoring language (TUTOR) had to meet technical specifications for PLATO to be considered an educational delivery system, courseware had its own unique structure. The PLATO courseware was developed by instructors from many fields in cooperation with courseware design specialists and courseware writers. This process was particularly prevalent in the community college program. Such an arrangement created a variety of approaches to the courseware. While satisfactory to the specific instructors who were using PLATO, its usability for other instructors with a different pedagogical outlook was questionable. In effect, the generalizability of the courseware was questionable.

As early as October of 1971, Schwartz, one of the National Science Foundation consultants, had mentioned in a letter to McWilliams that, while the hardware and systems software were impressive, the courseware effort was "thin" and the views of the PLATO group ". . . slightly ingrown." After a group visit in July of 1972, McWilliams wrote to Propst to say that the group was ". . . impressed by the state of the hardware and software (although clearly a lot of work remains to be done) and alarmed by the state of the courseware" but believed that the PLATO group's success with past projects gave him confidence that the problem would be solved. McWilliams raised the same issue in two memos to Propst in October of the same year. In the second memo, he noted that progress courseware development was "less impressive" while acknowledging that PLATO was getting excellent reception in its world-wide demonstrations. After a review of community college courseware by evaluators at Educational Testing Services, now contracted to do the evaluation of the PLATO project, the same issue of courseware problems was highlighted in a letter to Propst (Mohler & Alderman, 1973). The criticisms enumerated in the letter were:

1. There was a tendency to produce courseware for units which were easy to write.
2. There was no provision for review of courseware by external content specialists.
3. There were technical problems in the courseware units.
4. Some courseware was developed which was useful only to given instructors.
5. There was too much text in some frames, making it less effective in teaching remedial students.
6. Student-machine interaction was inadequate, negating or diminishing the benefit of an active learning experience.
7. Some computer responses did not use the correct dialogue.
8. Some of the math units were outdated.
9. Objectives as stated in the units were not met.
10. There was an urgent need for quality control over the production of courseware.

Within the community college program, resolution of the courseware problems was apparently accomplished by the hiring of full-time people to write the courseware. The 1977 Educational Testing Service evaluation of the PLATO project mentions the difficulty in having instructors write the courseware themselves. However, even though much courseware has been written by instructors, it should be noted that even today there does not exist a procedure for evaluating PLATO courseware at the University of Illinois. Much of the original courseware has never been distributed by Control Data Corporation.

There was one other example found of potentially negative consequences, this created by a key person during the early days of the PLATO project. A school in a large city was being considered as an elementary school site. However, one of the professional staff at the University of Illinois Curriculum Lab (Dennis, 1971) wrote to Bitzer and questioned the motivation of the principal of that school and thought that he might want to undermine the PLATO effort for his own personal gain. The principal had stated that inner city children were different and he was not interested in running an experimental school. Dennis went on to suggest a number of other schools where good relations existed and recommended that these be looked at first. The school in question was never made part of the PLATO project.

On February 16, 1972, Alpert was at a briefing conducted by Edward David, at that time the Science Advisor to President Nixon. In a note to his file, Alpert states that he had asked for David's support for a proposal the University of Illinois was making to the National Institute of Education. It is unknown whether such support was given. The proposal was never funded.

Step II of the Methodology, as it applies to this study, discussed some of those individuals and agencies which were influential in guiding the PLATO implementation and demonstration project and need not be repeated here. It would be helpful, however, to mention some of the commitments key people had made. List, at the

Ford Foundation, for example, was assigned to the higher education component of the foundation. After an early visit to PLATO in 1970, she wrote to Bitzer (1970) saying that she would pass on her favorable impressions to others.

Communications between the University of Illinois and the National Science Foundation describe a pattern of recognition of the important role commitment would play in the diffusion of PLATO. Writing to H. Stever, a director at the National Science Foundation (1972), Alpert stated that ". . . it is part of our plan to develop a continuing commitment from all of the participants in the initial phase I demonstrations." In its proposal to the National Science Foundation, the University identified four criteria for the distribution of terminals during the first year; two criteria would be used for the second year. All related to demonstrations of commitment. The first year criteria were:

1. Cooperation shown by the schools.
2. Commitment by the schools to the program objectives.
3. Willingness to have teachers trained.
4. Adequate site preparation.

The second year criteria were:

1. Experience gained during first year, such experience being a direct result of time spent on the project.
2. Progress in curriculum development, again an outcome of commitment.

There was also an awareness of the need to sustain a commitment by faculty at the University of Illinois. The apparent issue was that there was going to be a rewrite of the National Science Foundation proposal after its implementation. Alpert (1973) wrote to Bitzer expressing his concern about the rewrite, and that such a rewrite might cause the project to lose necessary faculty support.

Another problem occurred during the Implementation Period at the University of Illinois. Martin (1973), at the Office of the Vice Chancellor for Academic Affairs, wrote to Bitzer and Propst that the Committee on Program Evaluation did not rank the Computer-Based Education Research Lab for funding for the 1974-1975 and 1975-1976 Fiscal Years. The Committee felt that there were too many questions unanswered in the proposal. It gave the following:

1. Were the users getting timely service?
2. Are there any complete courses now developed on the campus?
3. What is the likelihood that PLATO will ever save money?
4. Is slow response time by the system occurring?
5. What is the current demand for PLATO terminals on campus?
6. Is the Computer-Based Education Research Lab Policy Committee functioning?

It should be noted that these questions were resolved to the satisfaction of the University, since funding continued and does continue for PLATO and the Computer-Based Education Research Lab.

A final comment on commitment. When the Educational Testing Service did its evaluation in 1977 (Murphy & Appel), it deemed it noteworthy to comment on the fact that all the remote sites which were funded by the National Science Foundation continued as PLATO users after the cessation of funding. That holds true even today (Propst, personal interview, October 30, 1986).

Summary

In summary, the PLATO project was one in which the participants (producers and linkage agents) were well aware of the role commitment would play in any success the project might have. Commitments by personnel at the remote sites were aggressively sought.

VI. Conceptualizing and Implementing a Linkage Plan

The Methodology

This step involves the identification and utilization of various communication resources such as workshops, printed material and formal training. The strategy involved can be pictured as two rings, the inner ring representing self-renewers and opinion leaders and the outer ring representing others in the target audience. Such others would ideally be influenced by the self-renewers and opinion leaders. Within the framework of the PLATO implementation and demonstration project, the goal would be to recognize the means of communication used to diffuse the innovation.

Results

The Educational Testing Services Evaluation of PLATO (Murphy & Appel, 1977) describes the context within which the community college component was implemented and demonstrated. Significant factors were:

1. The sites were sufficiently remote that long-range liaison between the University of Illinois campus and the various sites would be necessary.
2. Instructors were free to use PLATO as much or as little as they chose, including decisions not to use it at all.
3. Although it was expected and hoped that instructors would help to develop the courseware, there was no obligation on their part to do so. Later developments precipitated a change from remote to local courseware development.
4. The project was structured to permit a large degree of flexibility including:
   a. modification of software/courseware
   b. modification of instructional materials
   c. inclusion of new instruction into the project as desired.

The Educational Testing Service notes that the above factors ". . . were considered realistic conditions for future implementation of the PLATO system and important for optimizing the generalizability of the demonstration project" (p. 8). It also recognized that since the project's success depended upon the efforts of interested instructors, goals were stated in more general terms than would be the case when implementing ". . . innovative educational programs" (p. 9).

An example of the two-ring concept of implementing an innovation would be the University of Wisconsin-Extension. It was not part of the PLATO demonstration project. However, D. Gritzmacher of that organization had seen a PLATO demonstration in 1972. He subsequently wrote to D. Bitzer (1972) that he wanted more people to be aware of PLATO and would be in touch with the Computer-Based Education Research Lab staff to determine a method for proceeding.

Another example would be Control Data Corporation's approach to diffusing PLATO in a commercial environment. When Control Data Corporation acquired the rights to PLATO in the spring of 1976, it had been in the computer marketing business for over 15 years. For Control Data, it was initially a simple matter of purchasing an innovation to add to its product line without changing its overall marketing posture (W.C. Norris, telephone interview, December 19, 1986). However, a year later, Control Data did form an educational subsidiary with the focus on marketing PLATO and the necessary hardware and software (Control Data Corporation, 1985).

While the above suggests that the project went reasonably well in spite of its complexity, there were side issues which had to be resolved. Three problematical issues can be cited.

First, the University of Illinois was working with a number of funding sources during the 1972-1976 period. National Science

Foundation, with its initial five million dollar interest (later raised to eight million), Ford Foundation, Kettering Foundation, the Advanced Research Project Agency of the Department of Defense, and Control Data Corporation all had financial interests in the project. The National Science Foundation was concerned with these various interests and the impact they might have on the project. Although Alpert (1972) had written to McWilliams, assuring him that the work being done under the Advanced Research Projects Agency would not degrade the project but would aid it, McWilliams (1972) responded by reminding Alpert as to which funding agency ". . . is the tail and which is the dog (at least for the next three and one half years)". The Advanced Research Projects Agency, conversely, wanted to do behavioral studies on computer-assisted instruction (personal interview, D.L. Bitzer, October 27, 1986).

A second problem resulted from the rights to products (in the PLATO case courseware) developed under federal grants and contracts, specifically the National Science Foundation. Florida State University was one of the first universities to express an interest in acquiring a stand-alone PLATO system for itself. As early as 1970, Florida State University had sent faculty to demonstrations at the University of Illinois (Chamberlain, 1970). In October of 1972, seven Florida State University personnel and a member of the Florida State Board of Regents journeyed to the University of Illinois for a demonstration of the PLATO system (Brown, 1972). Bitzer also presented a remote demonstration at Florida State University (personal interview, D.L. Bitzer, October 27, 1986).

Although Florida State became the third organization and the second academic institution to install a PLATO system, completing the installation process in the fall of 1974, it did not gain access to the University of Illinois courseware. The following year, R.M. Johnson, Provost at Florida State University wrote H. Stever, a director at the National Science Foundation, stating that it was the opinion of Florida State University that courseware developed with federal (National Science Foundation) funds should be in the public domain. It was later resolved that the University of Illinois, as developer of the courseware, had rights to it and could sell it to Control Data Corporation, which it had done. The result of this was that the cost of acquiring a stand-alone system with University of Illinois courseware was more expensive than initially projected, at least as it pertained to Florida State University.

The third problem was how PLATO would be marketed. The choices were to develop a marketing capability at the University of Illinois or to sell the rights to PLATO, Control Data Corporation being the logical purchaser since it was Control Data Corporation equipment and system software which drove PLATO, so the necessary compatibility was already in place. However, the initial negotiations with Control Data Corporation had bogged down, prompting some people at the PLATO group at Illinois to urge that the former option be pursued, that is, to create a separate marketing activity under the aegis of the

University. Either approach could accomplish the goal of taking PLATO to the next level of diffusion, outside of the funded remote sites already in existence. In response to the request that the University of Illinois set up a separate marketing activity for PLATO, G. Russell, Vice President for Research and Dean of the Graduate College, stated that the outcome of a meeting among Chancellor Peltason, Vice Chancellor Weir and himself was that the University should not set up a marketing system for PLATO and that such a decision ". . . does clearly indicate that the campus is, and desires to remain, an educational institution and will not now take scarce resources to subsidize the development of a marketing organization" (1976). Shortly thereafter, the contracts with Control Data Corporation were submitted to the Board of Regents for approval with the caveat that the matter of negotiations and renegotiations with Control Data Corporation were complex but that they would represent ". . . a major far-reaching change in educational technology and mark the beginning of new delivery processes and systems which could affect virtually millions of persons" (University of Illinois, 1976).

Within Step VI of the Methodology is a description of the various forms of communications (one-way and two-way) that a linkage enterprise can utilize as a part of the diffusion strategy. The PLATO implementation and demonstration project used many, if not all, of these means of communication. The proposal to the National Science Foundation (University of Illinois, 1971) mentioned a number of activities in which the University of Illinois planned to participate to communicate the PLATO innovation during the first or implementation phase. These activities were:

1. Develop cooperative education programs with institutions which would involve commitments to participate in educational planning, field testing and evaluation programs.
2. Create memos of understanding with participating institutions.
3. Conduct workshops for participating institutions.
4. Develop plans and operating procedures (documentation).
5. Continue the already existing teacher training programs.
6. Provide assistance and coordination of functions at the remote sites. These would include:
    a. incorporation of the PLATO instructional system into the on-going educational system;
    b. instruction in the operation and use of PLATO;
    c. provision for on-going education and training of teachers;
    d. acquisition of data for the economic and educational evaluation components.

The following findings indicate the types of communications used in the diffusion of PLATO:

1. Workshops and institutes. During the implementation period (1972-1974), six members of the community colleges

were trained in the use of the TUTOR authoring language. The University of Illinois also conducted extension courses for community college instructors in the summer of 1972, the spring and fall of 1973, and the spring of 1974 (Murphy & Appel, 1977). About six percent of the Ford Foundation money was for teacher training.

2. Periodic meetings. A. Knox (1972) wrote to F. Propst, saying that the Computer-Based Education Research Lab was providing weekly support to the community colleges. The Computer-Based Education Research Lab's Elementary Mathematics group even included meeting of parents of students who would be using PLATO (Swinton et al., 1979).
3. Printed Materials. In Step IV of the Methodology as it applies to this study, the number of articles pertaining to PLATO was listed as well as a sampling of the journals in which the articles were published. During the implementation and demonstration period (1972-1976), published articles and papers presented continued to flow (Lyman & Postlewait, 1983).

Year	Number of Articles
1972	26
1973	36
1974	58
1975	65
1976	63

The following journals in which articles appeared give an indication of how broad an audience had the opportunity to learn about PLATO:

a. Chemical and Engineering News
b. Journal of College Science Teaching
c. Journal of Medical Education
d. Journal of Heredity
e. Mosaic
f. Modern Language Journal
g. French Review
h. Science
i. Population Dynamics
j. Educational Technology
k. College Management
l. Yearbook of Science and Technology
m. The Physiologist
n. Childhood Education
o. International Management
p. The Illinois Veterinarian
q. Mercury, Journal of the Astronomical Society of the Pacific
r. Journal of Research in Medical Education
s. Engineering Education
t. Creative Computing
u. Journal of Computer-based Instruction

v. Data Management

w. Journal of Experimental Child Psychology

x. Studies in Language Learning

y. Journal of Agronomy Education

z. Journal of Legal Education

aa. The Accounting Review

In addition to the above, a number of other articles were made available to the ERIC system. E. McWilliams (1974), noting that PLATO was a ". . . national entity . . .", urged personnel at the Computer-Based Education Research Lab to report periodically to the public, especially to those involved with computer-based education. The Association for Educational Data Systems (AEDS) specifically requested that someone from the PLATO group write an article for the AEDS journal (R. Smith, 1972). List, at the Ford Foundation (1971), recommended that PLATO be included as a computer innovation for a paper being prepared by A. Molnar at the National Science Foundation for UNESCO. One of the provisions in the Kettering Foundation grant was the development of a handbook for users at remote sites (Umpleby, 1973).

4. Other forms of media. One of the unique features of PLATO vis-a-vis other educational innovations is its electronic phone and mail capabilities. The ability to communicate via the computer on either a dynamic (phone) or electronic

storage (mail) basis allows participants to provide feedback to others regarding problems, solutions or to simply make comments. Such capabilities have become very popular in industrial as well as academic systems. PLATO was probably one of the first to include user-to-user communications.

5. Demonstrations. Of all the means of communication used during the PLATO implementation and demonstration project (as well as before and after), the demonstration is the most noticeable and probably the most important. While the other means of communication doubtlessly fulfilled significant roles, the ability to provide user-friendly regalia and visual effects in a computer environment had to have significant impact on those participating in or witnessing demonstrations. The review of the file of 1974 demonstrations (CERL) at the University of Illinois shows in part the following groups came for site visits:

    a. 4H members
    b. High school students
    c. College students
    d. Graduate students
    e. Industry
    f. Federal government
    g. Eight university presidents
    h. Steel workers

i. Representatives of the following countries:

   1. Japan
   2. Mexico
   3. Australia
   4. Germany
   5. Netherlands
   6. Denmark
   7. South Africa
   8. Hungary

j. University of Delaware

k. "Children"

l. U.S. Air Force

m. Future Secretaries of America

During that year, a total of 102 local demonstrations were recorded. The PLATO system was capable of being demonstrated on a remote as well as on a local basis. Remote demonstrations were of two types: first, demonstrations at remote sites which were connected to the Urbana mainframe on a permanent basis, and second, ad hoc remote demonstrations which were used to show the capabilities of the system but without the academic environment inherent at the permanent remote sites. As an indicator of the activity in remote site demonstrations of the second type, data was obtained which shows that 145 remote demonstrations were held in 1973; in 1975, 40 (no data was found for 1974). During the 1972-1973 time period, PLATO personnel gave remote demonstrations in Japan, Brazil, New Zealand, Scotland, France, England, and Canada (University of Illinois, 1972-1973). Russia and Venezuela also had demonstrations during that time period (D.L. Bitzer, personal interview, October 28, 1986).

Some of the demonstrations were fruitful since some institutions seeing the demonstration subsequently installed their own PLATO system. Florida State University, as mentioned previously, the second university to install PLATO, had visited the University of Illinois in October of 1972, and D.L. Bitzer gave a remote demonstration at Florida State University (D.L. Bitzer, personal interview, October 27, 1986). In July of 1974, a group from the University of Delaware, including Provost L.L. Campbell, was at the University of Illinois for a demonstration (PLATO, Local Demonstrations, 1974). It can be assumed that considerable interest was generated both prior to and during the demonstration since the following week the Manager of Systems and Programming at the University of Delaware wrote to N. Wood at the University of Illinois saying that he looked forward ". . . to bringing PLATO to the University of Delaware" (Falcone, 1974). The University of Arizona visited the University of Illinois in 1973 and it also became a PLATO user.

As mentioned previously, personnel at the Ford Foundation had visited the University of Illinois for a demonstration. Later, a remote demonstration was given at the Ford Foundation headquarters in New York City during the early months of the Ford Foundation Grant. W. Howell at the Kettering Foundation was at a PLATO demonstration prior to its funding of the citizens' involvement project (Umpleby, 1972). Earlier in the same year, a demonstration was held at the Pentagon, which had substantial contracts with the PLATO group through the Advanced Research Projects Agency.

While the above comments suggest that demonstrations of PLATO succeeded in diffusing the innovation, it is also true that the majority of visitors to the Urbana campus, permanent remote sites, or remote demonstration sites never acquired their own PLATO system. However, the number of people seeing PLATO in operation enabled it to become a well-known innovation.

There were two other remote sites for PLATO which warrant comment. First, E. McWilliams at the National Science Foundation requested that a PLATO terminal be placed in his office for advertising and an ". . . understanding of PLATO" (1972). S. Papert, at MIT, who had been a consultant to PLATO (Martus, 1976), also had a PLATO terminal in his office (Kampits, 1973).

There was also a recognition that users at the remote sites could serve as demonstrators. A. Knox, who was directing the community college component, stated that it was an objective to use the community college authors themselves to demonstrate the PLATO system to prospective users (1972).

6. The consultant. The PLATO project had the benefit of a number of consultants as it was being developed. Its uniqueness and structure allowed for considerable input from a variety of sources. Previous mention has been made of the consultants hired by the National Science Foundation to aid in the evaluation of the various computer-based education systems that were being developed. Documents show that these consultants did make visits to the Urbana campus to evaluate the PLATO system (McWilliams, 1973). One of the early consultants (Schwartz, 1971) had alerted McWilliams to the courseware development problem which McWilliams had passed on to the PLATO personnel. McWilliams (1972) was encouraged that the PLATO group was actively seeking help from the Regional Educational labs and was reconsidering the use of field-tested courseware written outside of the PLATO environment. The Ford Foundation grant authorized a small sum for consultant services (Howe, 1971).

The community college program, as previously mentioned, underwent a fundamental change during the project. The initial goal was to have instructors at the community colleges develop their own courseware after being trained in the TUTOR language. However, a lack of interest on the part of the community college faculty in writing their own courseware necessitated the hiring of design and programming specialists. Under their arrangement, the faculty became content specialists and served as consultants rather than authors in the courseware development task (Martus, 1976). Also, PLATO staff in the elementary mathematics curriculum section provided constant support in the classroom (Swinton et al., 1979).

Other types of consultants used extensively in the courseware development phase were the students themselves. Questionnaires completed by community college students indicate that a high percentage of them felt free to ask questions or express opinions concerning the courseware (Murphy & Appel, 1977). This feedback was even more important since the number of students in the community college program was approximately twice the number initially projected (National Science Foundation, 1976). The total number of participating students at all educational levels was 3,670 during the 1973-1974 academic year; 5,980 during the 1974-1975 academic year.

7. Formal training. The formal training consisted of workshops of two weeks' duration during the summer for elementary school teachers. These were held at the University of Illinois campus. Some were funded as part of the Ford Foundation grant (Howe, 1971). There was also significant and continuing help at the remote sites in the person of local coordinators. In addition to the remote site coordinators, there was significant continuing support provided by central site personnel. Prior mention was made of the ability to communicate in two on-line modes, either talk or electronic mail.

8. Designated job slot. The PLATO project appears to have been adequately staffed. Correspondence at the Ford Foundation mentioned that D. Alpert was actively involved in the PLATO project (Chamberlain, 1970), and that there was a highly qualified and dedicated staff (Howe, 1971). Further, the grant from the Ford Foundation was primarily for personnel. Of the total amount of $163,021 in the initial proposal, $120,489 was for personnel, including a full-time senior staff member for elementary education, a half-time educational analyst, and a half-time systems software designer (Howe, 1971). The proposal to the National Science Foundation identified the Computer-Based

Education Research Lab as a large organization headed by the active participation of D. Alpert and D.L. Bitzer (University of Illinois, 1971).

9. Informal interpersonal interaction. The nature of PLATO encourages the use of informal communications. While there are a number of independent PLATO systems, many of them are connected or can be connected via a dial-up link to the system at the University of Illinois. This permits exchange of information among the various PLATO sites on an intersystem basis. It also allows intra-system communication on an informal basis. Even within the PLATO group, informal use of the system is encouraged. A file of anecdotes is kept on the system, for example. The file keeps stories about PLATO, particularly stories that took place during the early stages. The number of demonstrations, both remote and local, provided a fertile ground for interpersonal communications. Time spent with interested viewers apart from the demonstrations themselves had to be substantial and meaningful.

Summary

In summary, Step VI of the Methodology as it applies to the PLATO project depicts many activities which aided in the diffusion of PLATO. There were instances of all the modes of communication mentioned in the Methodology. The product itself forced the involvement of self-renewers and opinion leaders who, in turn, influenced others. The result was that the PLATO project, during the period July 1, 1972 to May 24, 1976, logged approximately 2 million hours of terminal time on the University of Illinois system (Lyman, 1977).

VII. Ascertaining the Impact of Selected Knowledge upon a Targeted Audience

The Methodology

The final step of the Methodology focuses on the impact of PLATO. The four parts of this step are the determination of the information needs, the determination of how the information can be gathered, the gathering of the information, and the presentation of that information to decision-makers in report form.

Results

The Educational Testing Service contracted with the National Science Foundation to perform two evaluations of the PLATO project: one for the community colleges and one for the elementary schools. ETS was involved in this evaluation even prior to the actual start of the project, having presented its initial proposal to the National Science Foundation in August of 1971, about six months before the National Science Foundation negotiated the 5 million dollar PLATO contract with the University of Illinois. Murphy and Appel (1977) at Educational Testing Service were responsible for the evaluation of the community college component. Their description of the purpose of the evaluation was ". . . to provide information for decision makers in a variety of audiences, including the National Science Foundation which funded a large part of the implementation and demonstration; the developers who designed and executed the implementation and demonstration, and evaluation; the educational community interested in the potential of computer-based education; and the educational research community" (pp. 10, 11).

This statement suggests the wide scope of the enterprise envisioned by the evaluators and also by the National Science Foundation. McWilliams (1972) at the National Science Foundation had written to F. Propst at the Computer-Based Education Research Lab urging that ". . . we must make every reasonable effort to see that PLATO-related differences can occur, be noticed and analyzed. Nothing less is justified, under the circumstances." The circumstances were that the National Science Foundation had committed five million dollars (later increased to eight million) to the PLATO implementation and demonstration project. The evaluation alone was costing the National Science Foundation an additional two million dollars.

There was tension and conflict from the beginning concerning what information was needed in order to evaluate the project and that conflict continued throughout the term of the project (Slattow, 1977). Some of the issues were:

1. Educational Testing Service wanted to do a classical treatment of the effectiveness of PLATO in a real-world environment. PLATO personnel wanted an evaluation of the

system itself; that is, was PLATO effective as a delivery system without regard to the effectiveness of the courseware (Educational Testing Service, 1971). The main reason for this posture on the part of the PLATO group was that the initial goal, later revised significantly, was to encourage faculty and teachers to develop their own courseware. With the large number of remote authors involved in the project, the management of courseware quality would be an impossible task. Also, there was concern that the potential individualization of the courseware to the quirks and whims of the authors could create difficulties in providing valid pre-test and post-test results with any measure of external validity.

2. There was concern on the part of the PLATO people as to the representativeness of the community colleges and elementary schools selected for the project (D.L. Bitzer, personal interview, October 28, 1986). As it turned out, the process of selecting the elementary schools was tainted. Initially, some of the Chicago public schools were targeted for selection, since that would provide a test of PLATO in an inner city environment. That group of schools dropped out shortly after the project began. Terminals were never installed. Finally, a call went out to school districts asking for teachers to volunteer to help develop the reading and mathematics courseware.

While this self-selection process provided the PLATO group with schools considered to be innovative, it mitigated against results which would have external validity (Swinton et al., 1979).

3. Should the evaluation be summative or formative (Swinton et al., 1979)? At issue was how can a summative evaluation of the effectiveness of PLATO be meaningful when much of the courseware was being revised all through the implementation and demonstration period. For example, a certain lesson could be modified substantially based on feedback from faculty or students. Once that revision is in place and being used, evaluation of the effectiveness of the lesson is meaningless.

4. The University of Illinois intended and expected to do its own internal evaluation since it was looking for different information than Educational Testing Service. For example, Slattow et al. (1977) stated that one objective of the PLATO project was to develop plans and strategies with an external evaluator for a later determination of the effectiveness of PLATO. Illinois was not interested in an external evaluation during the 1972-1976 time period. They wished to take that time period to do their own evaluation in areas identified by Murphy and Appel (1977) in the community college report. Some of those areas of interest to the University of Illinois were

difficult to evaluate in quantitative terms. The major areas of interest were to determine if PLATO was an efficient and reliable operational system and whether the system could provide certain levels of usage; for example, at the community college, the goal was to have 300-400 students use PLATO in each of the five subject areas in several of the participating institutions each year during the 1974-1976 demonstration period. There was a clear distinction between usage and effect of usage.

Some other areas of interest as described by Murphy and Appel were:

a. The flexibility and adaptability of PLATO.
b. The ability of PLATO to teach using a variety of strategies (inquiry, simulation, etc.).
c. The willingness of instructors to develop their own courseware.
d. The ability of PLATO to provide individualized and remedial instruction.
e. Would PLATO's capabilities as a centralized teleprocessing system lead to the development of a communication network among the users?
f. Was PLATO able to provide stand-alone instruction?
g. Could the central site staff effectively support the remote sites?

h. Could a method be found to produce PLATO-related instructional materials for other institutions?

i. Could the TUTOR authoring language on-line training course provide adequate training of instructors at the remote sites?

Zimmer of the PLATO group at the University of Illinois (1976) mentioned a different goal of the PLATO project as it applies to the community college effort. He said that the ". . . primary goal of the field test has been to achieve local (remote site) commitment that they will sustain the use of PLATO . . . beyond the heavily subsidized field test period" (p. xiii).

The question of who would do the evaluation led to competition for the instructors' time to aid in the evaluations. Murphy and Appel (1977) mention in their community college report that getting the support and cooperation of instructors for the Educational Testing Service evaluation was a ". . . major hurdle" (p. 191). The issue was addressed by Slattow (1977) as well. He stated that the resolution of this problem was that the PLATO group did not accomplish its evaluation since a second request for teachers' cooperation would be too intrusive.

5. The issue of cost effectiveness or productivity of PLATO was too elusive to be resolved, particularly in what was

a development environment. For example, if it is proved that PLATO can teach, therefore freeing up the teacher, cost effectiveness can only be achieved if the teacher uses the newly found time in an effective manner (Swinton et al, 1979).

The final orientation of the evaluation plan by the Educational Testing Service for the community colleges (Murphy & Appel, 1977) centered on four areas: the attention of students, the achievements of students, attitudes of instructors and students, and behavioral characteristics of students. All of these factors included both PLATO and non-PLATO populations. The elementary school evaluation by the Educational Testing Service (Swinton et al, 1978-1979) was presented as a naturalistic inquiry using the case study method. The two evaluations by PLATO personnel at the University of Illinois were somewhat qualitative in nature and drew upon data collected by Educational Testing Service. As mentioned above, this approach was taken in order to spare participating instructors and students from being subjects in two evaluations. The areas in the community college which could not be evaluated by the Educational Testing Service (Murphy & Appel, 1977) were:

1. A comparison of PLATO with other computer-assisted instruction systems.
2. The effects of individual lessons.
3. The instructional materials themselves.

4. The cost or technical aspects of the PLATO implementation and evaluation.

The second part of Step VII concerns the method by which the data will be gathered. A review of the various evaluation reports (Murphy & Appel, 1977; Swinton et al., 1978, 1979; Slattow et al., 1977; Zimmer, 1976) identified the following major techniques used to gather data:

1. Pre-testing and post-testing within the various domains.
2. Teacher interviews prior to, during, and following the treatments.
3. Attitudinal surveys of faculty users and non-users of PLATO.
4. Attitudinal surveys of student users and non-users of PLATO.
5. Behavioral surveys of users of PLATO.
6. Observational studies of teachers and students while using PLATO.
7. Maintenance of daily logs by teachers using PLATO in their classrooms.
8. Narratives concerning the implementation and demonstration of PLATO.
9. Identification of support activities provided by the PLATO staff.
10. Anecdotal remarks considered significant.

While the above encompasses the major activities during the evaluation, a problem which slowed down the evaluation activity was the lack of familiarity with PLATO on the part of the Educational Testing Service (Slattow et al., 1977). This problem was created quite simply by the fact that the external evaluators were contracted to evaluate a system of which they had only the most rudimentary knowledge in the beginning. The problem was solved over time, but it points out an inherent difficulty of trying to evaluate a product (in this case, PLATO) without understanding it.

The third part of Step VII is to get the data. This need not be addressed as part of this study since the data was obtained. It does need to be pointed out that the data acquisition process was a demanding one. Data had to be obtained periodically at the various remote sites by the various evaluation teams, a more difficult task than in a more controlled "hot-house" environment.

The fourth and last part of Step VII is concerned with the reporting of the results. The four major evaluations have already been identified. In addition, there were a number of other reports generated which were based on the experience gained during the project (Avner & Avner, 1976; Call-Himwich, 1977; Francis, 1976; Mahler, 1976). The major evaluations generated reports of about 2000 pages in length. They provided decision-makers with insights of varying depths into all phases of the evaluation.

The reports by the Educational Testing Service were published. All the reports mentioned were made available through ERIC.

In spite of the difficulties engendered by and the demands placed on the PLATO project and its evaluations, the results as reported provided ample information for decision-makers. Some of the information generated was highly quantitative and other information was of necessity more qualitative in nature. The information generated was not of the type to create a rapid diffusion of PLATO beyond the test sites; on the other hand, there was ample evidence that PLATO had at least the potential to impact the way education is delivered.

The report by the Educational Testing Service which focused on the community colleges (Murphy & Appel, 1977) concluded that PLATO had no effect on student attrition and no significant impact on student achievement. It did, however, have a favorable impact on student and faculty attitudes. Few students felt that PLATO was dehumanizing or boring. The report went on to say that the PLATO project was conducted in a real-world environment with major roles being played by the colleges and instructors at the remote sites with satisfactory monitoring and support by the PLATO staff at Urbana. It concluded that PLATO worked well as a medium for the delivery of instructional materials in an interactive mode and that ". . . instructor control, present to a great degree in this implementation and demonstration, is the primary reason for the high user acceptance of the PLATO systems" (p. 190).

The Educational Testing Service evaluation of the elementary school component (Swinton et al., 1978, 1979) mentioned, as previously stated, that the PLATO project could not be characterized as a randomized experiment but rather a ". . . naturalistic study in which comparison could be made" (p. 2). Among its more salient results were that in the mathematics curriculum it was clearly successful when used in an adjunctive mode with teacher coverage, it could teach and also provide effective drill-and-practice work of concepts previously introduced in the classroom. PLATO did have a positive effect in computation but not in concepts. Attitude surveys showed some positive results. In the reading curriculum, the report concluded that there was a negative impact on reading but no effect on attitudes on reading.

The elementary school summary report by Educational Testing Service (Swinton et al., 1978), a separate and substantially smaller report, offered some conclusions of the PLATO demonstration project which would be generalized. It said that teacher effects were real and large and ". . . idiosyncratic" (p. 25); that although it appears that computer-assisted instructon studies can be replicated, its interactiveness with its setting suggests that it is no more effective than the corresponding curriculum; that the teachers demanded control over the system and responded more effectively when they were given control; that trying to develop the system and the courseware in parallel was hazardous; that much more attention needed to be devoted to the development of courseware; that the users were quite positive about PLATO as were the evaluators; and, finally, that the continued high cost of PLATO limited its potential as an instructional vehicle in elementary schools.

The University of Illinois report on the community colleges (Zimmer, 1976), while acknowledging some complaints concerning the system (mechanical problems, too rigid answer judging, and a lack of humor, graphics and motion in some lessons), stated that the system was found to be effective in the drill-and-practice mode at least. It raised two other important issues: the first was the matter of who should develop the lesson. The majority of instructors surveyed felt that faculty should write their own lessons because of what could be termed the unique nature of each group for whom the courseware was written. Second, the task of installing a functioning system such as a technological innovation in an operational environment is a non-trivial task and must be recognized as such.

The other University of Illinois report (Slattow, 1977) was generally qualitative in its analysis of the PLATO project. The report stated that the field test showed that there was a ". . . fertile environment . . ." for further adoption of the system by community colleges if the high cost of the system could be brought down (p. 141) and held out hope that new systems such as PLATO V had the potential to reduce those costs ". . . substantially . . ." (p. 142). It made favorable comment about the collaboration or linking which had taken place between the community colleges and the University of Illinois and this permitted maximum use of the institutional staffs.

The Slattow report provided some idea of the scope of the community college effort. During the 1972-1976 time period, over 175 community college teachers plus administrators and Computer-Based Education Research Lab staff were involved in the project; this group prepared 400 courseware lessons; the lessons were used by 21,000 students.

Within the elementary school component, the Slattow report said that of the three mathematics strands (or curricula), the Fractions strand was most successful. It attributed this success to the strand courseware being able to present individualized instruction dynamically; that is, it presented material based on the student's response to material just presented. The other strands, Whole Numbers and Graphics, did not have such flexibility. With regard to the Reading program, Slattow reported that both students and teachers responded enthusiastically to PLATO, making special note that acceptance increased as the teachers and students gained control over the system. Also, successful paradigms for the reading curriculum had been designed and implemented and that a philosophy had evolved concerning how the system would route students through the curriculum.

Comments concerning the PLATO effort at the University level during this period were brief, this effort being much smaller and less ambitious in scope, focusing on only some physics and chemistry courseware. The report stated that it found the students' attitudes toward PLATO were good in both subject areas. In the physics area, there was a decrease in students' class time but no significant difference in final exam scores. A survey of students using PLATO as part of the chemistry course showed that 96% of the respondents felt that PLATO helped them learn the material.

The Slattow report also made mentioned of the growth within the PLATO system during the 1972-1976 time period, which is an indication of the extent of the diffusion. It stated that, in 1972, there were 10 terminals connected to the system, all on the Urbana campus. By the end of the implementation and demonstration period, that number had grown to 950. Distribution of terminals was nationwide, inter-continental if the one terminal in Sweden was counted. New PLATO systems were now installed at Florida State University and the University of Quebec. Over 1 million terminal hours per year had been logged during 1975 and 1976. The average response time, critical in a time-sharing environment, was .2 seconds, which met the original design specifications.

Summary

In summary, the work done by the PLATO group conformed closely to the parts outlined in Step VII of the Methodology. Difficulty in defining what could reasonably be evaluated was a problem from before the project started until the final reports were prepared. This problem affected the course and conduct of all the evaluations. However, what was finally decided upon as areas for evaluation were clear enough to generate substantial information on the results of the change initiative undertaken by the PLATO project.

Summary

The presentation of data in this chapter is summarized in table form. The summary consists of repeating each step in the Methodology and then determining the degree of implementation of the step in the PLATO project. The placement in a given category is determined by the quality and quantity of data obtained, although it should be clear that such a classification might be disputed since it is neither mathematically nor statistically derived.

Table 1

Summarization of Data Showing Degree of Implementation of the Wolf-Welsh Linkage Methodology

Step	Full	Adequate	Partial	None
I	X			
II		X		
III		X		
IV		X		
V	X			
VI	X			
VII			X	

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The PLATO project during the period 1972-1976 was selected for the study of the diffusion of an innovation using the Wolf-Welsh Linkage Methodology as an analytic tool. The hypothesis presented is that the successful diffusion of PLATO during that time period would follow the seven steps of the Methodology. The project selected for study was large in terms of financial commitment by the University of Illinois and secondary funding agencies and also in terms of the number of people involved, especially in the linking and using aspects of the innovation.

A substantial amount of telephone and written communication during the early part of the research effort helped to refine the possible sources of data which might be used. Field trips were made to the National Science Foundation in Washington, D.C., the Ford Foundation in New York City, and the University of Illinois to gather relevant data and conduct interviews with key people.

The material obtained was then categorized as to the specific step(s) of the Methodology to which each item would apply. The data was then presented as relevant to each of the steps of the Methodology.

Conclusions

The following are offered as conclusions concerning the Wolf-Welsh Linkage Methodology and the diffusion of PLATO. The conclusions are:

1. Step I of the Methodology calls for a certain type of individual to serve as linkage agent. Findings show that the PLATO group was headed by creative and inventive people who brought to the project dedication as well as abilities.

2. Step II of the Methodology focuses on the targeting of an audience for a change initiative. PLATO was held out as a vehicle to meet expressed needs at all levels of education. This alone gave it a broad exposure across the educational segments without apparently diluting the implementation efforts.

3. Step III is concerned with the definition of knowledge to be adapted or adopted. PLATO was at the time of the National Science Foundation funding the only computer-assisted instruction system that had the capability of being installed at remote sites for only the costs of terminal hardware and communications. This allowed adoption without purchasing a costly mainframe; consequently, the system could be rejected at a later time without incurring a substantial write-off of the equipment. This served as a protective mechanism for the demonstration sites.

4. This step relates to modifying knowledge to accommodate the targeted audience's needs. One of the major advantages of PLATO was

that it could be adapted to the individual needs of the targeted audience. The individual instructor, frequently with the aid of courseware design and authoring specialists, was able to tailor courseware to meet his/her needs and even idiosyncrasies. All that the audience had to accept was the PLATO concept; all else could be created or modified by individual users.

5. Step V concentrates on the commitment to undertake and sustain the innovation. PLATO conforms admirably to this goal. Funders, PLATO staff, users and user institutions all made either formal or informal commitments to the projects. The National Science Foundation contributed an additional three million dollars when it was determined that a shortfall would exist. This allowed the PLATO group to provide courseware writers when it was determined not all users could or wanted to write their own instructional modules. Proof of sustained commitment is that all remote users funded under the National Science Foundation continue to use PLATO, more than ten years after the cessation of funding.

6. Step VI concerns itself with the development of a plan for linkage. Again, the plan that evolved within the PLATO group closely approximates the Methodology. From the selection of remote sites to the use of the various communication modes recommended in the Methodology, there was an intensive effort to work with the right people (self-renewers and opinion leaders), and the right institutions, all with the ability to effectively support the effort.

7. The seventh and final step of the Methodology relates to determining the impact of selected knowledge upon the targeted audience. One of the items within that framework was to determine the data needed by decision makers for proper analysis of the change initiative. This was not really accomplished before the change initiative took place as recommended by the Methodology. The conflict of whether to evaluate PLATO as a delivery system or as an effective "teacher" was never resolved appropriately and was a handicap all during the time of the PLATO project. However, a plan was implemented and voluminous reports have been written on the project.

Finally, in answer to the question: would the use of the Wolf-Welsh Linkage Methodology have served the PLATO project well, the answer is yes. The data suggests that its use, even in such a robust and widespread enterprise, would have permitted effective diffusion of the PLATO innovation.

Recommendations

The conclusion that the Wolf-Welsh Linkage Methodology would have been a good tool for the successful diffusion of PLATO leads to the following statements:

1. The PLATO system was and is the most costly computer-assisted instruction system ever developed and is one of the most, if not *the* most, educational innovations ever diffused. Within the previously described limits of an *ex post facto* study such as this,

the Methodology held up well as an analytical tool, despite the fact that the evaluation of the project, although generally positive, was a disappointment to the developers.

2. The selection of PLATO as an innovation to be studied using the Methodology was appropriate since its very scope permitted the acquisition of a reasonable amount of data although not in readily available format. While the selection of a smaller project would have the advantage of a narrower focus, there would be the offsetting disadvantage of not having enough information available more than a decade after the project was completed. Using a more recent project of smaller scope might optimize the advantage and minimize the corresponding disadvantage.

3. The Methodology can be used effectively to do additional <u>ex post facto</u> studies to simulate its use. However, such use does not provide a real life exercise of the Methodology.

4. The historical approach to innovation theory has been to describe the process, identify some variables, and assume that the variables were the causal agents in the innovation. However, such an approach permits embedded errors. To successfully evaluate the variables in an innovation process, there ideally should be a means to manipulate the variables thereby creating different outcomes and therefore being able to identify those variables which have an effect and, conversely, those which do not. The complexities of social science research plus the impracticability of setting up the

diffusion of an innovation using various strategies, that is, manipulating variables, makes such an ideal impossible to obtain.

Although the difficulty of evaluating innovations in a classical sense remains, the use of the Wolf-Welsh Linkage Methodology in innovative projects just beginning or about to begin is recommended and encouraged. Its prescriptive nature provides guidelines for success as well as alarms for caution. Continued use and evaluation of the Methodology can bring to bear on innovation theory a useful tool and one relatively simple to use.

5. The Methodology operates without regard to the quality of the product, practice, or idea. Some means of an early evaluation of the product, etc. would provide a quality control element.

6. The term "linkage agent" becomes difficult to deal with. In this study, developers were linkage agents in the beginning and later turned this task over to others, some of whom were initially users.

7. Control Data Corporation assumed the marketing of PLATO at the time the implementation and demonstration period was coming to a close. A study of how the corporation diffused PLATO using its resources is warranted and recommended as a follow-up to this study.

Appendix A

WOLF-WELSH LINKAGE METHODOLOGY
(Sixth Revision)

WOLF-WELSH LINKAGE METHODOLOGY

(Sixth Revision)

I. Qualifying for Linkage Responsibility

Qualifications and attributes believed to be related to successful linkage agent performance are identified in Part I. The person or persons who have assumed responsibility for a linkage initiative are asked to reflect upon what is expected of them in light of these qualifications and attributes. This self-appraisal is designed to highlight an individual's strengths and limitations. If the former outweigh the latter, full speed ahead. If the latter takes precedence, proceed with the linkage initiative most cautiously.

A. Qualifications believed to be related to successful linkage agent performance.

1. Person has successfully linked some aspect of knowledge production with some aspect of knowledge utilization within an institutional setting at least once, preferably twice.
2. Person's professional background and demographic characteristics and the professional background and demographic characteristics of the typical member of a targeted audience are reasonably compatible.
3. Person either has been trained to do some aspects of the following work or is accustomed to contracting with specialists for work desired.

a. Assess needs of targeted audience.

b. Survey literature for various reasons, be able to retrieve pertinent material, and be able to meaningfully summarize results.

c. Ascertain demographic characteristics and attitudes of targeted audience.

d. Conceptualize and then expedite linkage strategies.

e. Conceptualize and then expedite evaluation strategies.

f. Prepare coherent project reports.

4. Person understands basic elements of individual and group motivation and is able to apply such know-how routinely.

B. <u>Attributes believed to be related to successful linkage agent performance</u>

1. Person is able to devote considerable time (hopefully, at least one day per week) to a linkage task.

2. Person can be counted upon to deliver promised services on time.

3. Person listens well and communicates effectively.

II. <u>Targeting an Audience for a Change Initiative</u>

Targeting an audience for a change initiative can be a simple task or the task can be most complicated. An example of simplicity: all the professional staff of one elementary school who have been targeted to modify some aspect of their instructional methodology. An example of complexity: targeting and involving people who may have an impact upon the resolution of a student absenteeism problem known to exist within a large school system. Three ways to define a targeted audience are described in Part II. These procedures are recommended to help the person or persons responsible for linkage work to focus upon "appropriate" members of a targeted audience.

A. Define parameters of a targeted audience in three ways:

1. Ascertain the threads which are held in common by all members of a targeted audience (i.e., all persons affiliated with an urban high school; all persons who have submitted proposals to an administrative unit of the National Science Foundation; or, all persons associated with the marketing division of a large corporation).

2. Identify the total number of persons in a targeted environment apt to be affected by the change initiative.

3. Clarify roles of persons who comprise a targeted audience (i.e., students, teachers, counsellors, librarians, supervisors, and administrators associated with an urban high school).

B. Identify the individuals and collective units (i.e., an elected school board) who assume responsibility for decision making within a targeted audience.

1. Determine the responsible individuals involved.

2. Determine the decision-making paths followed routinely.

C. Identify persons within a targeted audience who are most likely to influence the direction and the outcome of change enterprise envisioned.

1. Conduct interviews with selected decision-makers in order to identify a small set of persons within a targeted audience who strive to modify and to improve upon whatever it is they do routinely.

2. Conduct interviews with selected decision makers and/or carry out a simple sociometric survey in order to identify a small set of persons who function as "opinion leaders" within a targeted audience.

III. Defining Knowledge to be Adapted or Adopted

Three different approaches to the definition of knowledge (i.e., practices, products, and ideas) to be adapted or adopted are spelled out in Part III. Definition encompasses (a) needs assessment, (b) knowledge identification, and (c) knowledge selection *modus operandi*. One, two, or all three approaches may be called for in a given situation. How many are utilized must be determined by the person or persons responsible for the linkage work.

A. <u>Identify a targeted audience's need to modify some aspect or aspects of their practice.</u>

1. Ascertain needs of the targeted audience to modify practice, using inquires like the following:
    a. Examine relevant materials (for example, local, state, and federal education agency documents) for policy shifts, expansion, or contraction.
    b. Conduct surveys of various members of the targeted audience (use a packaged needs analysis methodology if applicable and if time permits).
    c. Compare practices of targeted audience with practices of other similar groups.
    d. Examine available test results.
    e. Examine available demographic data (i.e., population trends) which pertain to the targeted audience.
2. List and prioritize needs of targeted audience.
    a. Prepare a list of the identified needs.
    b. Distribute the list to various members of the targeted audience for the purpose of determining their priorities (repeat as necessary until a clear picture of priorities unfolds).
    c. Use members' responses as a point of departure for establishing a prioritized list of needs.

3. Clarify who will participate in the final selection of the specific need or needs to be addressed (i.e., a committee, all involved persons, etc.).
4. Use the following criteria to facilitate selection of the specific need or needs to be addressed:
   a. Resources required to meet the need or needs.
   b. Time required to meet the need or needs.
   c. Positive and negative consequences associated with meeting the need or needs.

NOTE: If the needs of a well-defined targeted audience have been ascertained, simply review what has been accomplished in light of the elements of Step A. Carry out only that work which has been overlooked during or deleted from the initial effort.

B. <u>Identify practices, products, and ideas apt to meet identified needs of a targeted audience</u>.
   1. Determine existence of practices, products, and ideas apt to meet need or needs.
      a. Search existing information repositories for desired know-how (i.e., ERIC, EPIE Institute, CEDaR Catalog, the PREP reports, etc.)
      b. Search catalogues of publishers and other vendors for desired know-how.

c. Survey other groups like the targeted audience to find out what relevant practices and/or products are being used.

d. Survey selected members of the targeted audience for desired know-how.

e. Survey specialists for desired know-how.

2. Prepare a list of the available practices, products, and ideas apt to meet the need or needs.

NOTE: If a specific practice, product, or idea is known which probably will meet the need or needs identified, and if further searching and surveying does not seem appropriate or necessary, work called for in Step B may be reduced or eliminated entirely.

C. <u>Select practices, products, and ideas apt to meet identified needs of a targeted audience.</u>

1. Distribute the prepared list of practices, products, and ideas to various members of the targeted audience for the purpose of determining their priorities (repeat as necessary until a clear picture of priorities unfolds).

2. Prioritize the list on the basis of responses received.

3. Clarify who will participate in the final selection of the practices, products and ideas.

4. Establish criteria like the following, set forth conditions for acceptance/rejection, and then use the criteria to facilitate selection of the specific practices, products, and ideas.
   a. Resources required to effectively utilize selected knowledge.
   b. Time required to effectively implement the selected knowledge.
   c. Positive and negative consequences associated with the implementation of the selected knowledge.

NOTE: If a specific practice, product, or idea is known which probably will meet the need or needs identified, work called for in Step C may be reduced or eliminated entirely.

IV. Modifying Knowledge Selected to Accommodate Identified Needs of a Targeted Audience

Given the selection of an acceptable practice, product, or idea, it is important that someone contemplate ways to tailor the selected knowledge:

a. to enhance compatibility with current practice;
b. to facilitate adaption or adoption;
c. to be in tune with available resource potential.

Responsibility for planning and for executing such a task rests with the person or persons utilizing the Wolf-Welsh Linkage Methodology. Modification can assume varied forms; several worthy options are highlighted in Part IV.

A. Ascertain the extent to which selected knowledge is compatible with generally accepted attitudes and practices of targeted audience members.

1. Interview "key" members of the targeted audience to obtain information desired.

2. Information obtained will suggest subsequent work.

   a. If information obtained suggests considerable compatibility exists, little if any work is in order.

   b. If information obtained suggests considerable incompatibility exists, the following actions are in order:

      (i) Review specifics of the selected practices, products, or ideas for the purpose of isolating troublesome elements.

      (ii) Delete troublesome elements if possible.

      (iii) If troublesome elements cannot be deleted, reduce them to their least controversial form.

      (iv) Make plans to cope with all aspects of adversity related to the controversial elements which can be anticipated.

B. Divide the selected knowledge into its most basic elements to accommodate proposed pilot tests and partial adaptions or adoptions as well as full-scale adaptions and adoptions.

1. Conceive alternative plans to subdivide the knowledge selected.

2. Communicate available options to opinion leaders within the targeted audience.

3. Elicit feedback from opinion leaders pertaining to the viability of plans made.

C. Estimate the cost and ascertain the availability of resources required to adapt or adopt some or all of the knowledge selected.

1. Communicate relationships perceived between target audience resource potential and target audience adaption or adoption aspirations of persons responsible for financial and other resource allocation.

2. Collaborate with persons responsible for financial and other resource allocations as necessary to facilitate initiation of some or all of the desired work.

V. Obtaining Commitments from Key Persons to Initiate and Sustain a Change Undertaking

Persons within the targeted audience who are most likely to influence the direction and the outcome of a change initiative were identified in conjunction with Part II of the Wolf-Welsh Linkage Methodology. The posture assumed by these "self-renewers" and "opinion leaders" toward the knowledge selected will relate directly to the success or failure of the undertaking. Hence, significant effort must be expended by the person or persons responsible for the linkage work to obtain their support. Part V provides some direction for such effort.

A. <u>Determine attitudes of key persons toward the knowledge selected for adaption or adoption.</u>

   1. Interview selected "self-renewers" and "opinion leaders" to ascertain their attitudes toward the knowledge of interest.

      a. Affirmation is the response preferred; however, neutrality or indifference is also a plus in that such responses present a challenge to the linker(s) to try harder.

      b. Opposition suggests plans being implemented are not viable; such a response calls for the following actions:

         (i) Review specifics of the interviews completed to isolate the sources of controversy.

         (ii) Confront the sources of controversy and attempt to overcome them or neutralize them.

(iii) Discontinue the change enterprise if the opposition persists in force after remediation efforts have been completed.

(iv) If a need continues to be apparent, return to Part II and try again.

B. Obtain commitments from key persons to support the change enterprise.

1. Solicit "testimonials" from "self-renewers" and "opinion leaders" which can be used as needed to support and to sustain the change initiative.

2. Obtain commitments from "self-renewers" and "opinion leaders" to participate during early stages of the change undertaking.

   a. Participation may involve communication activity to obtain peer group support.

   b. Participation may involve cooperation during pilot test activity.

   c. Participation may involve actual adaption or adoption of a portion of or all of the selected knowledge.

3. Obtain commitments from "opinion leaders" to assume some (or considerable) responsibility for conceptualizing and implementing the kinds of in-service training activities required to sustain and/or to expand the change undertaking.

VI. Conceptualizing and Implementing a Linkage Plan

Linking knowledge production and needs of knowledge users is a complex task in most cases. The task involves the selection and utilization of appropriate communication resources to inform, to persuade, to facilitate verbal interaction, and so forth. Some resources serve one-way communication needs well, whereas some facilitate two-way well. Here are examples of nine communication "modes" intended to perform such functions:

Mode	One-Way	Two-Way
1. Workshops and Institutes		X
2. Periodic Meetings		X
3. Printed Material	X	
4. Other Forms of Media	X	
5. Demonstrations	X	X
6. The Consultant		X
7. Formal Training		X
8. The Designated Job Slot		X
9. Informal Interpersonal Interaction		X

Persons using the WWLM can be expected to assume responsibility for the conceptualization and implementation of a linkage plan. The plan called for juxtaposes one or more (preferably more) communication "modes" within an overall linkage strategy. Linkage strategies may vary from one context to another and from one point in time to another.

Three ways to prepare and expedite a linkage plan are offered in Part VI. These procedures are suggested as a point of departure to the person or persons who have assumed responsibility for the change enterprise.

A. <u>Conceptualize a strategy which meets five conditions:</u>

1. The strategy is geared primarily to the enterprise of persons identified as "self-renewers" and "opinion leaders," but it also involves all persons who will be influenced by modifications in practice.
2. The strategy involves two steps: step one focuses upon "self-renewers" and "opinion leaders"; step two utilizes these persons to influence others in the targeted audience.
3. The strategy makes maximum use of interpersonal (preferably face-to-face and two-way) channels of communication.
4. The strategy is participative in that all persons who are to be affected by the modifications in practice participate somehow in making decisions about the undertaking.
5. The strategy incorporates a time line which projects the realization of specified aspirations.

B. <u>Arrange for a critique of the strategy conceived.</u>

1. Elicit feedback pertaining to the strategy from selected key persons.

2. Use feedback provided to modify the strategy.

C. <u>Implement the strategy in two steps.</u>

1. Expedite step one of the two-step plan.

   a. Utilize selected interpersonal channels of communication to introduce the practices, products, and ideas of interest to the previously identified "self-renewers" and "opinion leaders."

   b. Work closely with these persons until a core of them have modified their practice as desired.

   c. Recruit from the core of successful adaptors/adopters a small number willing to become involved in generalizing the modifications in practice to other persons within the targeted audience.

2. Expedite step two of the two-step plan.

   a. Utilize selected interpersonal channels of communication to share information about modifications in the practice of the recruited key persons with other members of the targeted audience.

b. Work closely with the recruited key persons during their attempts to persuade selected peers to modify practice as desired.

c. Continue the process of interaction until a substantial core of the targeted audience has modified professional practice as desired.

VII. Ascertaining the Impact of Selected Knowledge Upon a Targeted Audience

Much varied data can be obtained to ascertain the impact of selected knowledge upon a targeted audience. Data which address considerations like the following may be sought by decision makers, for example:

1. The number of persons who could have and the number of persons who actually did modify their practice as desired:
   a. Characteristics of the set of persons who opted to modify their practice as desired.
   b. Characteristics of the set of persons who opted not to modify their practice.
   c. Similarities and differences between the two sets of persons.
2. Perspectives, derived from the adapting or adopting set of persons, pertaining to whether or not their needs were met.
3. Perspectives, derived from the adapting or adopting set of persons, pertaining to positive and negative effects of the implementations upon their practice.

4. Relationships between resource consumption and time allocation on the one hand and the utilization of desired knowledge on the other.

Such data can be obtained by the person or persons responsible for the linkage work. Part VII suggests a plan to ascertain consequences of a change initiative.

A. <u>Determine targeted audience decision makers' information needs prior to the initiation of change work.</u>

   1. Try to define goals of the change initiative in collaboration with selected decision makers.

   2. Try to elicit from selected decision makers the nature of data which could be employed by them to pass judgment upon the change initiative.

B. <u>Establish a plan to obtain data believed to be of importance to decision makers.</u>

   1. Either contract with an evaluation specialist or accept responsibility for the execution of work envisioned.

   2. Make certain that decision makers approve plans formulated.

   3. Make certain that plans formulated can be expedited within the framework of available resources.

C. Implement the evaluation plan agreed upon.

1. Either contract with an evaluation specialist or accept responsibility for the acquisition of data desired.

2. Organize data in ways: (a) that will facilitate meaningful communication with decision makers, self-renewers, and opinion leaders; and (b) that will serve to inform all other members of the targeted audience about progress being realized.

D. Prepare a report which highlights relationships between goals set forth and consequences of the linkage work.

Appendix B

QUESTIONS FOR MR. WILLIAM C. NORRIS, CONTROL DATA CORPORATION, DECEMBER 29, 1986

1. What made you think PLATO could be marketed commercially?

2. Were you getting feedback from others on the merits of PLATO or were you the sole evaluator?

3. What did you envision the targeted audience for PLATO to be? What was the initial marketing plan?

4. When the courseware license renewal was due, the decision was made not to exercise the renewal option. Was this indicative of a lack of confidence in the existing courseware?

5. The integration of PLATO into curricula required a substantial change in how users (teachers) would operate. Was CDC involved in determining the willingness of teachers to change their teaching methods? If so, how was the willingness determined?

6. You obviously have had a long-standing interest and concern for the process by which we deliver education. Furthermore, you were willing to commit substantial resources to bring about the incorporation of PLATO into academics. What were the factors that caused you to decide to "buy into" PLATO vis-a-vis other similar systems?

7. It is my understanding that PLATO was developed with traditional academic settings in mind. However, I am aware that PLATO was marketed extensively and successfully to industry. How did the decision to market PLATO to industry come about?

8. What changes, if any, had to be made within CDC to market PLATO as a stand-alone product? That is, CDC was primarily a hardware manufacturer, was it not?

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