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ABSTRACT

Arguing in the introduction that designing information systems must involve the integration of social/organizational as well as technical activities, and assuming that the contribution of social scientists studying innovation will be enhanced through increased participation in the design process, this paper presents a case study in the generation of innovation. The innovation under consideration is an electronic document delivery system (EDD) under development in the Office of Research at the Online Computer Library Center, Inc. (OCLC), an international, nonprofit cooperative founded in the late sixties to serve libraries with automated cataloging services. For this study, data on OCLC was gathered intensively over a period of 18 months, beginning in 1979 and periodically in the years since that time. An argument is made in the paper for viewing information systems from a socio-technical perspective as early as possible in the design stage of innovation, since without consideration of the social, an idealized technical design concept may not move forward as a practical social system as it has been conceived. The literature of action research is reviewed for its relevant application to the generation of innovation, and several essential arguments are derived from the study. (Thirty-eight references are attached). (NH)

Information System Design:

A Case Study in the Generation of Innovations

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Abstract

This paper presents a case study in the generation of innovations. The innovation is an electronic document delivery system. The paper advocates that communication researchers interested in innovation study design as well as diffusion. An argument is made for viewing information systems from a socio-technical perspective as early as possible in the design stage of innovation. Without consideration of the social, an idealized technical design concept may not move forward as a practical solution. The interrelated nature of the two domains requires us to view the process of design as an activity which may extend beyond the technical R&D environment, and perhaps beyond the social system as it has been conceived. The literature of Action Research is reviewed for its relevant application to the generation of innovations.

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Abstract

This paper presents a case study in the generation of innovations. The innovation is an electronic document delivery system. The paper advocates that communication researchers interested in innovation study design as well as diffusion. An argument is made for viewing information systems from a socio-technical perspective as early as possible in the design stage of innovation. Without consideration of the social, an idealized technical design concept may not move forward as a practical solution. The interrelated nature of the two domains requires us to view the process of design as an activity which may extend beyond the technical R&D environment, and perhaps beyond the social system as it has been conceived. The literature of Action Research is reviewed for its relevant application to the generation of innovations.

1. Introduction

Effective engineering seeks to make desirable results possible. However, the process by which we achieve it is poorly understood. A great deal can be learned both by observing and participating in the process of innovation generation. For it is at this earliest stage that many tacit assumptions about human nature and behavior are embedded into an innovation. It is also at this stage that an innovation is most malleable. With many technological innovations it it easy to see that the costs of modifying a design will be higher after rather than before commercialization. This paper assumes that the contribution of social scientists studying innovation will be enhanced greatly through increased participation in the design process.

Rogers and Picot (1983) and Rice and Rogers (1984) have observed that social scientists tend to become involved in studying innovation only after implementation, which limits their involvement to taking evaluative roles. Rogers (1983) notes that there is little social science literature on the topic of the generation of innovations, compared with what is available on the topic of subsequent diffusion. However, that which is available does shed some light

on the pre-diffusion stage of innovation. This case study contributes to an understanding of the process of innovation in communication technology.

The innovation is an electronic document delivery system, used for the storage and retrieval of scholarly journal articles. Early work on the system began in 1979, although the current status of the project is far different than had been anticipated at the onset. Data was gathered intensively over a period of eighteen months, and periodically in the past year since that time. During that time, the principal author observed and participated in a research and development project at a major information industry corporation.

A lesson illustrated by the case study is that information system design may follow a very circuitous path. It is argued that design specifications are not necessarily the outcome of precise, *a priori* modeling, as suggested by the typical basic/applied research dichotomy. This paper focuses on the inductive process in the context of a technical research and development project. Following the case study, a general approach is advocated for confronting the social and technological issues of an emergent, and still evolving design concept.

2. Case Study: OCLC's Electronic Document Delivery Project

Globe et al. (1973) have analyzed retrospectively the evolution of ten scientific and technological innovations, including the heart pacemaker, grain hybridization, electrophotography, oral contraceptives, and the video tape recorder. They identified "decisive events" in the history of the development of each innovation. Their analysis revealed 21 factors of importance "to the direction and rate of the innovative process" (p.6), which include: *motivational influences* (recognition of scientific and technical opportunity, recognition of need); *management action* (e.g., venture decisions, funding

availability, market analysis, R&D management support); *peer group forces* affecting the R&D environment (existence of an invisible college, in-house colleagues, external direction of R&D personnel, and competitive pressures); and *unplanned or accidental factors* (serendipity, technology confluence). Other factors include demonstration of *technical feasibility*, presence of a *technological gatekeeper* who identifies relevant scientific and technical information, presence of a *technical entrepreneur* or "product champion," and *patent/license considerations*, i.e., the unique proprietary value of the innovation. Globe and his colleagues found the presence of a technical entrepreneur to be the most important factor in the success of nine of the ten innovations. Also of high importance are early recognition of need, adequate funding, and technology confluence. The authors found interdisciplinary research to be an essential ingredient for the fullest exploitation of technological benefits.

The R&D project studied reveals that the design project shares many of the characteristics which underly innovations studied by Globe et al. Presented below is a case history of an electronic document delivery (EDD) system under development in the Office of Research at the Online Computer Library Center, Inc. (OCLC) in Dublin, Ohio. OCLC is an international, not-for-profit cooperative, founded in the late sixties to serve libraries with automated cataloging services. OCLC maintains the world's largest online database of bibliographic records, contributed to daily by its members. The database serves several functions for OCLC members, including providing a streamlined method of cataloging acquisitions and a backbone to the world's most comprehensive telecommunications-based interlibrary loan network. OCLC has proven to be very successful financially as a computer-based library service cooperative.

OCLC's Office of Research focuses many of its R&D activities around finding ways to enhance the online catalog system and its subsystems (e.g., acquisitions, interlibrary loan). However, an increasing amount of research is being done to explore the applications of new information technologies for unique services to scholars and other library users. These efforts are geared towards developing services not directly related to OCLC's main line of business, namely, the enhancement of the online catalog services. One such application is OCLC's electronic document delivery (EDD) research project, the aim of which is to provide computer-based access to the full text of scholarly journals currently available only in print. Work on the project began in 1979 and has continued to the present day.

2.1. Why Electronic Document Delivery?

A great deal of research is done on the topic of scholarly communication. Sociologists of knowledge, philosphers and historians of science, and information scientists who study citation networks are all somehow involved in examining the relationships between scholarly communication and the growth of knowledge. It is not difficult to understand why one of the world's most prolific groups of "information workers" (scholars) would have its own special range of communication needs. Thus it is not surprising that scholarly communication has received focused attention at least since the early 1960s, when authors such as Machlup (1962) and Price (1963) noted the alarming increase in the rate of growth in scholarly publishing.

Today, a subtopic of scholarly communication which has its own following is electronic publishing. The many researchers occupied with impact assessment and system design issues include Ackoff et al. (1976, 1978), King (1981), Gell (1983a, 1983b), Garson and Howard (1984), Gurnsey and

Henderson (1984), Standera (1985), and Battin (1986). Indeed, the topic of electronic publishing for scholarly communication has its own "invisible college." That is, there is a group of researchers, not bound by disciplinary distinctions, sharing activities and interests in the evolution of a set of related concepts (Price, 1963; Crane, 1972; Chubin, 1983). The remainder of this section discusses issues in the design and implementation of electronic document delivery for scholarly communication.

Electronic document delivery (EDD) should be viewed as a solution to the needs of *scholars* , for that is the target group being served. There is the perception of the need to find a technological solution to improve the ability of scholars in gaining access to publications vital to their research interests. As research areas grow there is a tendency towards the development of sub-specialties (Campbell, 1969). Perhaps new associations and journals will emerge. This has occurred recently in fields such as biotechnology and artificial intelligence. A difficulty for the scholar in these specialties is the problem of keeping up with the relevant literature in their areas of specialization, as well as following trends in the mainstream. Ackoff et al. (1976), King (1981) and others have attempted to document this problem and they consider electronic access the desirable solution.

However, there is not unanimous agreement about this general solution among the relevant constituents. The parameters of the problem and the parties who must be involved in the solution include other players in addition to OCLC and the target market of scholars. These other players are scholarly publishers and universities. In other words, the problem and its solution will have to be defined as being both technical *and social,* with "social" being defined in terms of the broad organizational requirements for maintaining or transforming the infrastructure of scholarly communication.

The boundaries of OCLC's EDD system do not necessarily fit within existing structures. For example, electronic publishing technologies probably will displace microforms (microfilm and microfiche) as archival media. However, there is a great deal of difference between the two types of media. Electronic storage and retreival enables the user to have random access, in contrast with the linear method of searching microfilm and the relatively slow means of locating items using microfilm or microfiche. The implications for this technological change are profound for the publishers of scholarly journals. Microforms of periodicals, such as those produced by University Microfilms International (UMI) never became a popular medium for end users at their desks. Their function has been archival, and their location primarily in libraries. Microform readers are relatively unpleasant to read from in comparison to original printed materials, and the copies made from reader/printers generally is inferior to photocopies in quality.

In light of the relative undesirability of microforms and their limited use, the fact that publishers receive no remuneration per article copied by library patrons has not been a serious issue. If a high-quality electronic document delivery (EDD) were marketed aggressively as the archival altemative, it would introduce a threat to publishers. From an end user's perspective (and not only a library's), electronic journal systems could become the media of choice, particularly in light of the powerful storage and retrieval capabilities. But from a publisher's perspective, it means a gradual weaning away from the old print-based revenue stream and a need to rely increasinly on revenue from EDD. Many scholarly publishers have begun to consider seriously the ramifications of EDD technology for their industry and their individual firms (Society for Scholarly Publishing, 1985). OCLC's EDD

prototype is one of the projects getting such attention, both from the publishing and the library communities.

Integration of EDD technology into the mainstream of scholarly communication may require a different financial relationship between publisher and reader. The relationship between *libraries* and end users may change as well (Battin, 1986). Today, some library budgets are used in part to subsidize the electronic information needs of patrons, primarily to search abstract and index, though not full-text, databases. In the future, it may be reasonable to expect a university to provide financial support for scholars to retrieve from their self-tailored periodical collection. Compaine (1984) forsees a situation where "Managers will have to explain the need to shift some funds from asset acquisition in the form of books, to expense categories for communications and data-base services" (p.115). EDD systems such as OCLC's might require serious rethinking about the relationship between libraries and their patrons. The "haves/have-nots" issue could become a divisive one for scholars if university libraries resist considering electronic information delivery as an extension of their services.

The OCLC system has serious implications for the future of scholarly communication. However, as this section has noted, integration of the system into the routines of scholars may require discarding old models of the relationships among scholarly publishers, university libraries and scholars. In light of this difficulty, needs assessment, system design and implementation planning cannot be based on routine types of data. The fact that this innovation steps outside the domain of existing practices leads to the preliminary conclusion that the nature of relevant data is not evident *a priori*, but becomes apparent during the design process.

2.2. Evolution of the EDD Project

Rogers (1983) has noted that many technological innovations in fact are *technology clusters* consisting of "one or more distinguishishable elements of technology that are perceived as being closely interrelated" (p.226). Some such clusters contain both hardware and software components, as is the case with OCLC's electronic document delivery prototype. Though the hardware for the system is state-of-the-art, none of it was developed by OCLC. Rather, the value-added contribution from OCLC has been through the development of proprietary software. Rogers also has noted that slack resources within an organization are vital for the generation of innovations. Indeed, this has been the case with OCLC's EDD system development. In 1979, early work on the project was initiated "just for fun," according to the senior scientist in charge of the project. Initially, an interest was taken in the possibilities for using digital typesetting (the formatting of text and graphics) and digital fonts (character designs) to print library catalog cards. Software development for the first few years consisted exclusively of designing digital fonts. The goal was to develop a hardware-independent format to display bibliographic information both on paper and on-screen.

In the first year of font development, a daisy wheel printer was used. It was a discarded office unit, no longer used by the secretarial staff. Using the period on the daisy wheel, repeated passes were used to create each character. A Tandem mainframe computer was used for font development. Later, when a dot matrix printer was purchased, font design was done on a DEC personal computer, the reason being that local control became necessary to run the printer at speeds higher than 300 baud. By 1982, two sets of digital fonts had been designed at OCLC, resembling the classic Helvetica and Times Roman families. Development of the digital fonts was not an "official" research

project at first. Personnel who worked on the EDD system also did work on projects for OCLC's mainstream library automation research needs. However, it was slack demand on human and technological resources which enabled the innovative EDD project to emerge. The project was able to continue and expand due to sustained availability of resources and the recognition by R&D and general management that EDD is becoming increasingly viable for the library world.

OCLC continues to design proprietary digital fonts and is now marketing them commercially. During the process of font development and learning to use a digital typesetting system for printing library catalog cards, it also became apparent that other applications of this capability existed, namely, electronic publishing. Through informal arrangements with various well-known scientific and technical publishers, sample composition tapes first were acquired in 1981. The project team simply was curious to see if it would be possible to translate the typesetting information of the tapes into another digital typesetting system more suitable for electronic publishing. Simultaneously, a digital camera was acquired for the purpose of scanning the graphics which were not contained in the composition (digital typesetting) tapes.

By this time, the EDD project had gained sufficient momentum and financial support that it was an official research project. OCLC management frequently reports the status of the EDD project to library members through trustee meetings, brochures and the annual report. At various conferences in the U.S. and Western Europe, the project's director regularly reports on the status of design and development. By the Fall of 1986, OCLC had invested millions of dollars on the project, and has committed to eventual implementation in 1988. The number of personnel working on the project

went from a senior research scientist with two part time research assistants to the present project team consisting of several full time employees in research and development, including senior scientists, software analysts, programmers, and development planning managers. Several powerful Apollo microcomputers with high resolution screens, a new digital scanner, laser printers and other hardware were committed by management for use by the EDD team for software development. By this time, a great deal of scholarly and trade press attention had been given to EDD, offering optimistic support. OCLC management has operated on the assumption that it is in a unique position to offer technological expertise to bring EDD to the market it already is serving, namely, libraries.

Since early 1984, efforts have been made at OCLC to assess the market potential for the electronic document delivery system. Extensive data on current players and likely entrants in the electronic publishing industry has been collected and analyzed, leading to the conclusion that there is a great deal of momentum and convergence, both technologically and market-wise. Efforts have also been made to pinpoint likely primary markets for electronic journals. Periodical borrowing patterns over OCLC's interlibrary loan subsystem have been analyzed. This has been instructive in disovering what types of journal literature is most heavily shared. Through bibliometric citation analysis, networks of related journals have been identified and analyzed. Through such analyses, central and peripheral journal collections can be defined, thereby permitting OCLC to target cohesive market segments.

Some of the most useful social data collected for the project thus far has been based on the issues of interorganizational relationships. If OCLC were to commercialize the service, the "market" would be scholars (perhaps represented by their academic libraries) and publishers. An ongoing

dialogue in trade and academic publications among these constituencies deals with micro- and macro-social design-related issues. It can be fairly said that the interest, investment and activity levels are high within this group, in spite of the fact that little has been demonstrated retrospectively about the actual market potential for EDD in scholarly communication. Through personal contact from business relationships and conferences, and through a variety of publications, concerns about design-related issues in EDD both technological and organizational, are being addressed.

Thomas Hickey, director of the project, has noted the interested but guarded position taken by publishers regarding the potential shift of revenues from a paper-based system towards an electronic one (1986). Prototype demonstrations at library conventions, combined with focus group interviews of professional reference librarians, have also been a source of valuable data about perceived advantages and disadvantages. At the time of one set of interviews in the Summer of 1985, the system design was based on a central, telecommunications-based processing concept. Under this scenario, users would connect with a central database to access articles, and they would be billed on the basis of number of articles retrieved, connect time, or some other per-use charge. Focus group interviewees responded negatively to the concept of being billed each time they use the system. Their preference was to have unlimited access for a fee. However, these same librarians also were favorably impressed with the *concept* of EDD. Shelf space could be freed for new book acquisitions if old bound volumes of journals could be replaced by access to an electronic database. EDD access would be quicker than through shelf retrieval and photocopying printed volumes, and the output more aesthetically pleasing than with microforms.

At about the same time, CD-ROM (compact disk, read-only-memory) technology had begun to receive a great deal of attention as a dense-capacity storage medium.* Partly because of the availability of the technology, and partly in response to librarians' interest in the archival potential of EDD, a distributed processing system was designed to replace the old central processing system. In this way, control over access would be placed in the hands of each user. Under the present distributed processing concept, users (whether librarians or scholars) would pay a subscription fee for their copies of the disks, in return for which they would have unlimited access. The old centralized system concept, where users connect to a distant mainframe, has been discarded. Presently, all development efforts are based on a *distributed processing model,* marking a fundamental shift in organizing and thinking about electronic information services. Most recently, through the convergence of portable and dense storage media (CD-ROMs) with more "intelligent" computing power (RAM, processing), greater control power and flexibility is in the hands of the end user.

2.3. Description of the Current Prototype

There currently are many electronic document delivery (EDD) systems in commercial operation. Mead Data Central's Lexis , Lockheed Corporation's Dialog , and the Dow Jones News Retrieval Service are three of the most widely-known ones. However, these and most other systems are similar in that they are text-only. Such enhancements as digital typesetting and graphics capabilities currently are not in use by most commercial systems. OCLC's prototype EDD project is more ambitious in its objective in trying to provide

* Today, there is rapid growth in the availability of databases in CD-ROM format, including R.R. Bowker's *Books in Print,* Grolier's *Electronic Encyclopedia,* the *ERIC* Database, and University Microfilm's *Dissertation Abstracts* (Tiampo, 1987).

electronic storage and retrieval of periodical literature while replicating the appearance of the original printed version.

The system does not rely on facsimile technology to scan print journal pages. To do so would make it impossible to search the full text within. Rather than having the scanned page be the smallest unit, it is the individual character, just as in text-only systems. Initial input into the EDD system is from publishers' composition tapes. The key distinction between the OCLC prototype and existing text-only systems is that, rather than strip out typesetting control information from the publishers' tapes (as done with other online versions of printed publications), this information is used to produce a remarkably similar electronic version. Digital fonts, similar to the ones used in print editions, help to more closely approximate the original.

From a standardization viewpoint, although most journal publishing today is done with digital typsetting, there unfortunately are a number of different systems in use. Consequently, an EDD production system must be capable of translating the various formats into a common language. Much of the R&D for this project has been centered around software development for the conversion of different typesetting formats to a single one. The results of this effort comprise a substantial part of the proprietary aspect of the project. However, as the Standard Generalized Markup Language (SGML) for computer composition and editing becomes more widely used, much of the translation problem will have been eliminated, leaving only the final step of conversion to OCLC's display and printing format as the key concern. In a current OCLC project to develop an electronic encyclopedia for chemistry literature, the SGML is being used as an intermediary step between the publisher's format and OCLC's.

Another heavy OCLC investment in proprietary software development has gone towards the design of the information retrieval system, which enables the user to search not only bibliographic information, but also the full text of the articles. A principal motivating factor in this development is to increase the speed of retrieval, thus decreasing the waiting time for the searcher. In summary, OCLC has developed all software modules which have been incorporated into the EDD system, including digital fonts and typesetting, retrieval, display, and printing. At present, the interface for the retrieval system is based on a "spreadsheet paradigm," with function key commands enabling the user to move from one screen to the next without memorizing a great deal of syntax. The possibility of offering multiple options from selection of alternate interfaces is also being explored.

All of the hardware for the prototype user system is "off-the-shelf." It includes an IBM PC/AT with a floppy and a hard disk drive, a Hercules graphics board, an Imagen 300 dot per inch laser printer, and a Sony CD-ROM reader. Current prototype CD-ROM discs contain all of the retrieval and display software, digital fonts, typesetting information and the text files, leaving only printing software to reside on the magnetic hard disk. Effort has been taken to develop a system which is as hardware-indpendent as possible, thereby enabling users to choose from a variety of hardware alternatives. It is assumed that a potential adopter will be more attracted to the purchase of harware that can be used for other purposes besides electronic document retrieval. For example, the system is also capable of printing on a dot matrix printer with fairly high quality output, a much less expensive option for some users. A key to this effort has been the maintenance of "software portability."

Presently, the system contains approximately one year's worth of monthly issues of two prestigious chemistry journals, which is several

thousand pages of text and graphics. As with many areas of science and technology, chemistry journals rely heavily on the use of tables and figures, which makes the complexities of publication greater than with other journals. While tables tend to be typeset along with the rest of the text, and thus are contained in the composition tapes, many figures are not. Figures of chemical structures are scanned as facsimile images and electronically "pasted in," analogous to the process which was used for the print-based publication. At this time, scanning graphics from printed copy would be the most labor-intensive aspect of a production system. In the future, publisher application of computer aided design tools for developing graphics may improve the ability to integrate graphics and text.

As evidenced by the use of CD-ROMs (compact optical disks) for document storage, the prototype system is based on a distributed processing model. The system as currently designed is completely stand-alone. Being PC-based, retrieval is controlled locally. The system is designed to retrieve and display articles at the user's screen, or to print the article. The prototype uses a laser printer, which produces output that looks like a photocopy or facsimile. However, the system is designed to print on lower resolution devices, such as dot-matrix printers.

The retrieval system and its interface enable the user to use Boolean operators (e.g., and, or, not) to search by author, article and journal titles, and character strings in both the abstracts and the full text of articles on the entire database at once. As currently designed, the prototype easily could reside in the offices of individual scholars and professionals. As hardware prices decline, such an option increasingly is affordable. Another possibility is that local area networks could be used to interconnect a group of users with similar information needs.

* * *

In summary, the OCLC electronic document delivery (EDD) project reflects many of the factors found by Globe et al. (1973) to be common to the research and development project they studied. Indeed, there has been recognition of a technical opportunity, as well as the perception of need. Considerable management action has been taken, including financial and marketing support. Peer group forces, defined by an invisible college of researchers and practitioners focused on EDD, also exists. There have been unexpected and welcomed instances of technology confluence, particularly the availability of compact optical disc technology. Of key importance, the project has had from the start a technical entrepreneur (champion) who has remained closely involved in all aspects of the project's development, both technical and non-technical. Finally, the system has unique factors which give it proprietary value, namely, software.

Unfortunately, Globe et al. recommend little about how to confront sociotechnical issues. Perhaps this is due to the retrospective perspective taken. Consistent with this paper's advocacy of social scientists participating in the design of communication systems, the following section discusses this issue in the context of the case study.

3. An Action Research Perspective

Comroe (1977) examines several developments in medical science, noting that many of the great advances in medicine have come about through serendipity. His study reveals how medical researchers tend to present their findings in a

rational way, conforming to the IMRAD style (Introduction, Methods, Results, And Discussion). Comroe, a medical researcher himself, has observed:

> Even a little gentle probing has taught me that most scientists don't like to be regarded as discoverers, but rather as scientists who have meticulously and logically planned each step in a direct line leading from ignorance to full knowledge. Few "tell it like it was" in their scientific writing, and editors of journals probably delete, as unscientific, most of the "chance" story that authors do put into their manuscripts (p.64).

The same criticism is made by Thomas Kuhn (1970) when he decries the use of the retrospective "textbook tradition" of teaching science. He concludes that students receive a disservice if scientific pedagogy leads them to assume that scientific discovery invariably is a rational endeavor that is mapped carefully in advance.

The study of social intervention can be seen in a similar light. An engineering design, or any other form of social intervention, simply is an experimental treatment based on theoretical knowledge and assumptions, whether espoused or tacit. Intervention is based on an explanation of how humans behave, or will behave. This perspective assumes that social research about social intervention is most effective through direct involvement. It is *not possible* to postpone collecting social data until after the technical design is completed (evaluation). Since we cannot avoid getting social impressions, we should attempt to be sure they are accurate ones. In other words, designers of information systems should foster the context for testing the validity of assumptions about the social environment during the design process.

A research tradition which adheres to this perspective is "Action Research" (Lewin, 1952; Trist, 1968; Argyris & Schon, 1974, 1978; Argyris, 1980; Rickards, 1985; and Schon, 1985). The basis of what Argyris (1980) calls "action science" is that understanding and explanation, at least in the social sciences, are not ends in themselves. Rather, they are means to action, and

action requires dealing with real-world constraints such as "politics" and "personalities," and not simply dismissing them as error factors. An underlying premise of this perspective is that "distant knowing," the kind of knowing with which science has come to be identified, is ineffective in guiding action in novel contexts.

Argyris (1980) advocates research which seeks a high degree of accuracy, which he defines as the degree to which actors achieve their objectives without unrecognized, unintended consequences. It includes predictability and validity with the added dimension of *applicability*. The "bottom line" for action research is effectiveness in social intervention. Parsimony, while desirable, is not essential. Instead, action is based on the "thick descriptions" of qualitative research. "Action scientists" do not advocate this approach to data collection in all situations, but the tendency towards preferring it is increased as the phenomenon being modeled becomes less routine. In other words, the novel social context challenges the theory underlying a decision about how to intervene, more so than the stable, routine context.

Argyris (1980) argues that pre-structured data, while precise, generally is useful only if the action to be taken is framed within the boundaries of an established model of behavior. Application based on high-precision models requires replication of the control conditions maintained during data collection. Thus, control over the intervention is unilateral. That is, the intervention represents only the casting of the problem and the proposed solution from the perspective of the initiator. Added to this is the high risk, indicated by large amounts of unexplained variance, that the intervention will occur in circumstances other than those planned for. Argyris (1980) attributes the reluctance to give advice among many social scientists engaged

in high-precision modeling to lack of trust in the accuracy of their own findings.

Many practitioners subscribe to what Schon (1985) calls the school of "Technical Rationality," which he refers to as "the Positivist epistemology of practice" (p.31). Essentially, the technical rationalist subscribes to a well-defined basic/applied research dichotomy. "The researcher's role is distinct from, and usually considered superior to, the role of the practitioner" (p.26). Practice in the school of Technical Rationality consists of identifying a problem as one of a stock of known problems, and selecting a solution from a stock of known solutions. The professional practitioner simply acts within the problem domain as defined by the scientist.

The problematic dichotomies between theory and practice and the social scientist and the practitioner are not specific to the design of new media systems. However, as numerous authors argue, value*-neutrality is an unreasonable aim in social inquiry, for example: "The researcher who aspires to be descriptive is actually maintaining a normative position of conservatism" (Argyris, 1980). "...one must stress that the explicit intention of those who advance such [empiricist] theories is to give an objective and value-neutral account of the 'facts,' not to pass off their value judgements as factual descriptions (Bernstein, 1976). These same authors generally call for an honest acknowledgement of the normative role played by social research, thereby challenging the duality of "objectivism and relativsim" (Bernstein, 1985).

* The term "value" is used broadly here to refer to preferences, opinions, and possible subjective points of disagreement among stakeholders, and does not refer exclusively to controversial moral issues. Kuhn (1970) also uses the term in this context when he notes that members of scientific communities hold common values for scope, simplicity, fruitfulness, etc.

Argyris (1980) notes that there are many instances where social research need not go beyond the domain as it has previously been defined in order to arrive at effective intervention. This would be the case where the domain need not be redefined due to the nature of the desired intervention. However, the types of problems facing the designers of new media systems are not stock problems. Because of the absence of precedents for new media systems, there is a high degree of uncertainty about their potential effectiveness, both for the organizations advancing them and for their users. The economic costs of commercializing innovative media channels can be very high, and some of the failures in recent years (e.g., Knight-Ridder's "Viewtron" and RCA's Videodisc venture) indicate that even large, financially sound firms can overestimate their influence over a social domain.

If the practice of system design is based on a basic/applied dichotomy, where the practitioner acts solely within the parameters of the problem as it has been set by the detached social scientist, then the designer is confined to reinforcing the status quo. As Rickards (1985) and Schon (1985) both note, an action research perspective demands three recurring stages: an unfreezing of beliefs, a state of fluidity where the problem is reframed and a new solution sought, and a refreezing.

Those involved in information system design (engineers, managers, social scientists) need to be open to continually examining old conceptual frameworks which may fail to reflect the social and technological situation. In other words, they must in Schon's (1985) terms, become "reflective practitioners." Indeed, many engineers do fit this description. As Checkland (1984) argues, the stereotype of the engineer as "anti-human" or "anti-creative" is harmful and inaccurate.

The point argued here is not that engineers need to be "humanized" by social scientists. In order to be effective in designing new information systems, the engineer must be able to deal creatively with knowledge about both the social and technical environment. Designing information systems must involve the integration of social/organizational as well as technical activities. Speaking about the issue of integrating the social and the technical in the design of information systems, Turoff (1985) notes, "Any attempt to make either the social system or the technological system the independent or the dependent variable is only a short term artifice that might well give the wrong indicators of what is happening." Turoff's argument is based on the same premise as that of action research, which is that the domain should be construed broadly to include all of the relevant stakeholders: "Whether consciously or unconsciously done, the people involved, the social relationships, and the technology are all design elements for the experiment. One cannot apply reductionist methods to the social studies of this area."

In the case of OCLC's electronic document delivery (EDD) system, there are a number of fronts on which operating assumptions are being challenged. Internally, OCLC is faced with a shifting emphasis in its orientation as a service organization. The EDD system discussed in this paper introduces the potential to move access to a broad collection of scholarly journals from the library to the scholar's desktop. Will universities endorse a policy of subsidizing "libraries without walls?" If the trend is to resist, OCLC's EDD system may be viewed by library administators as a usurpation rather than an extension of the library's function in academia. Such a reaction would tend to jeopardize the future potential of the service since OCLC is a library cooperative. Indeed, the proposed EDD system requires a reconceptualization not only on the part of academic libraries, but also of OCLC's organizational

objectives. Is OCLC's primary constituent libraries, or *library patrons?* Casting this issue into the language of action research, the issue becomes one of "re-framing" the problem definition (Schon, 1983) rather than relying on a historical, descriptive account of the action context.

Another organizational issue is the shift OCLC would make from being a carrier of secondary (bibliographic) information to carrying primary (full text) information. In doing so, OCLC will enter into a much closer relationship with the publishing world. As already noted, scholarly publishers may be apprehensive about the introduction of EDD as the medium of choice rather than as a simple, limited substitute for microforms because it would erode their print-based revenues. In order to support the growth of EDD and simultaneously remain financially viable, such organizations would need to conceive of new pricing strategies. Meanwhile, OCLC would have to deviate from its present library-only orientation and enter into a new set of financial relationships with scholarly publishers. Again, the domain of relevance must be redefined to incorporate the concerns of a unique set of stakeholders. As Gray and Hay (1986) note, "The initial boundaries of an interorganizational change project are shaped by the legitimacy of the stakeholders participating." In this case, a unique interrelationship among publishers, libraries, and university libraries is being shaped in part by the evolution of this project.

In summary, OCLC is re-examining assumptions underlying its technical activities and determine whether the circumstances implied by its involvement in EDD are possible given its current set of inter-organizational relationships. Compaine (1984) stresses the need for information industry organizations to maintain flexible perspectives on their roles in the light of shifts in the content, process and format of new media. He argues that media

organizations be prepared to question old system boundaries and, if necessary, dissolve them in order to adapt to a changing media environment. In the case of OCLC, its ability to serve the information needs of scholars through electronic document delivery will be a function of its ability to transcend old organizational structures and develop a new model of action.

A continual re-evaluation of its interdependent relationships with libraries, as well as a thorough exploration of its potential relationship with publishers are both essential. Highlighting the need to tie innovative evaluation structures together with innovative intervention concepts in information system design, Turoff (1985) argues, "One is chiefly concerned with the design of the process and putting in place a process that allows for new goals and objectives to emerge and for those to influence the design process in some sort of feedback or evolutionary manner." In summary, the ideal design situation is one in which the concept of "reinvention" (Rogers, 1983) is defined as synonymous with an ongoing interaction between the phases of design and evaluation, and in which the involvement of stakeholders is recognized and supported for both phases.

4. Conclusions

Case studies serve an inductive function, in contrast with the deductive function of a hypothesis test. If any generalized deductions are to emerge from this study, they are likely to come from one who compiles data about the similarities and differences among a number different information system design efforts. However, some essential arguments derived from this study include:

* It is the responsibility of the social scientist to acknowledge the normative implications of his or her explanations. Cognitively distancing practice from theory creates an artificial gap which interferes with effective design. In practice, all intervention is a statement of theory (theory-in-

use), and is best recognized as such. If the social scientist is to play an effective role in designing information systems, that role must include explicit recognition of a practitioner funtion.

* Serendipity, in the way of the convergence of technological capabilities or in the emergence of new possible organizational relationships, is an essential though perhaps overlooked apect of the generation of innovations.

* Although design and evaluation occur sequentially, the steps are iterative. Recognizing the lack of finality in any social intervention, a key is to continually monitor the action context in order to reassess it, thereby leading the way to further innovation and reinvention.

* Defining the relevant social domain and identifying the related stakeholders is a core activity of problem definition in interorganizational intervention. By definition, stakeholders share power over the domain and are thereby constitutive of the relevant data. The issues advancing and stalling interorganizational consensus are the focus of data at least as critical as precise data about end user responses.

* In the course of designing an information system, or creating *any* social intervention, technical and social/human factors are synergistic. Among the practitioners involved in information system design, the engineer is a social scientist and the social scientist is an engineer. While capitalizing on individual practitioners' strengths, it is essential to recognize that both functions are played by all who are involved in the process..

* Evidence for the potential of an information system design which calls for a unique definition of the relevant domain and stakeholders will be different than if the domain had been established through prior consensus and intervention. Intervention within routine contexts may benefit from data, the nature of which emerged from precedent. However, given a novel domain, it is reasonable to expect the emergent data to be unique and not subject to a priori precision.

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