Action and Artifact:
The Structuring of Technologies-in-Use

by
Wanda J. Orlikowski

WP #3867-95 November 1995

Action and Artifact:
The Structuring of Technologies-in-Use

Wanda J. Orlikowski
Sloan School of Management
Massachusetts Institute of Technology
50 Memorial Drive
Cambridge, MA 02139
(617) 253-0443
wanda@mit.edu

October 1995

ACKNOWLEDGMENTS

The author gratefully acknowledges the support of the Center for Coordination Science at the Massachusetts Institute of Technology. The paper has benefited from comments made by participants at the Winter Conference on Technology, Innovation and Organizations, Stanford University, December 1994.

Action and Artifact:
The Structuring of Technologies-in-Use

ABSTRACT

This paper proposes "technologies-in-use" as a concept for analyzing technological use and change in organizations. Technologies-in-use are proposed as the situated and patterned interactions of a technological artifact and human action. Such a perspective facilitates an analysis of the technological capabilities actually realized in practice, instead of depending on accounts of prescribed features, or the social constructions made of them. This distinction between the technology-as-used and the technology-as-artifact helps to overcome some of the difficulties faced by the multiple, equivocal notions of technology characterizing prior organizational research. The usefulness of the perspective is illustrated by examining two firm's deployment of a particular information technology artifact and the various technologies-in-use enacted by the actors who used it. The paper suggests that a focus on technologies-in-use offers a systematic analytic lens with which to examine the various kinds of action taken with technological artifacts in particular contexts, how and why these differ, and how and why they may be associated with different intended and unintended organizational outcomes.

Technology does not exist in a vacuum. It is used in specific organizational contexts, interacting with work practices, social cognitions, political cultures, and institutional structures. The use of technology in organizations is neither uniform nor invariant, but thoroughly shaped by the intentions, interests, interpretations, interactions, innovations, and inertia of human agents. As organizational researchers, we know this about technology and its use, but for years our theories have struggled to fully account for the situated and interactive nature of technology. In this paper, I propose a framing of technology that may help some of these struggles. In particular, I argue that "technology"--the technology of interest in organizational research--is not sensibly conceptualized apart from the everyday activities of humans in specific historical and contextual conditions, and as such must be understood as a social practice.

The history of technology studies reveals a number of different approaches to conceptualizing technology (see reviews by Barley, 1988; Marx and Smith, 1994; Powell, 1988; Scott, 1990). In these different approaches -- contingency (e.g., Blau et al. 1976), sociotechnical (e.g., Trist et al., 1986), labor process (e.g., Knights and Willmott, 1988), social constructivist (e.g., Pinch and Bijker, 1984), network-based (e.g., Burkhardt and Brass, 1990), and structurational (e.g., Barley, 1986) -- technology has figured variously as material object, control mechanism, knowledge, task environment, social construction, social object, and social structure. Despite often deep ontological divides, these perspectives have in common an interest in the impact of particular kinds of technology on work, skills, performance, roles, structures, cultures, and so on. Their research focus, by design, assumes that technology is separable and separate from human action. This sort of detachment may be useful for purposes such as investigating macrotrends in technological deployment across organizations and industries, but as a general assumption about the nature and influence of technology in organizational life, it is misleading. It is misleading, because technology is of little organizational significance if it is not applied or used. As Orlikowski (1992a:410) notes, "It is only through human action that technology *qua* technology can be understood." To appropriate Kent's (1993:11) point about language: technology becomes technology only when it is used, and this use of technology -- technology-in-use -- defines its nature and its influence in human affairs.

The framing of technology outlined in this paper focuses on technology not as physical entity or social construction, but as a set of constraints and enablements realized in practice. A key proposition is that the technological artifact used or made sense of by actors, is analytically different from what actors actually do with that artifact in practice. Such a distinction has been blurred in the past, and as a result, our understandings of the role of technology in organizations have often seemed unduly materialistic or subjectivist. A number of scholars have called for a

distinction between technology and technology in action (Sproull and Goodman, 1990; Weick, 1990), but this has not yet been incorporated into our studies and conceptualizations of technology. This is my intent here. While the perspective I offer here is premised on the centrality of agency in technology use, it also recognizes that technologies have an artifactual nature. This perspective acknowledges the duality between, on the one hand, *technology as artifact,* a bundle of physical and/or conceptual features characterized by particular material and informational properties, and on the other hand, *technology-in-use,* the patterned interactions of human agents with a particular technological artifact in specific historical and contextual circumstances.

The theoretical shift proposed here is not simply semantic, but has critical practical and research implications. The positing of technology as a duality of action and artifact provides a conceptual apparatus with which to recognize and examine when and how technology use departs from *a priori* expectations, prescribed features, or intended outcomes. Rather than seeking uniform and universal effects from particular material objects, or examining the various consequences resulting from different social constructions, this perspective focuses on identifying the practices that actors engage in with particular technological artifacts in various historical and institutional contexts. In the following, I use the notions of enactment (Weick, 1979) and structuring (Giddens, 1984) to develop the concept of technologies-in-use as the situated and patterned interactions of technological artifact and human action. I illustrate this theoretic framing by drawing on an investigation of various actors' experiences with a particular technological artifact, a software product intended to support collaborative work, in two organizational settings. The empirical evidence highlights, not only that different actors interpreted and appropriated the artifact differently, but that they enacted different social practices with it. It is in identifying and understanding these technologies-in-use, that organizational research can offer a systematic yet situated and dynamic account of the nature and influence of technology in organizations.

TECHNOLOGICAL ARTIFACTS AND TECHNOLOGIES-IN-USE

The duality of technology posited here is of artifact on the one hand, and the situated patterns of use involved in utilizing that artifact, technology-in-use. A technological artifact can be seen to be a set of features bundled together into an identifiable and bounded package. Such features may be material (as in a tool such as a hammer), conceptual (as in a technique such as TQM), or both (as in a computer imaging device and its prescribed radiographic procedures). Artifacts are usually designed and developed under the auspices of explicit objectives and to some particular specifications. Correspondence between constructed artifact and developers' objectives is certainly not guaranteed, particularly in the case of complexity and novelty. On the contrary, the production

process typically generates modifications and deviations -- intended and unintended, recognized and unrecognized -- that result in an artifact that resembles but rarely reproduces an *a priori* design. Once developed, an artifact is packaged, labeled, and marketed so as to convey a certain impression of its features and potential functionality. Whether through persuasion or imposition, artifacts then get deployed in a variety of historical and organizational contexts of use, where some or all of their features may be appropriated by actors in their ongoing practices.

In their action, actors' intentions, interpretations, and institutional context influence how they utilize the artifacts. While the artifact and context of use may prescribe and proscribe particular images and forms of use, how actors make sense of the artifact and what they actually do with it is not predetermined. The use of technological artifacts is an ongoing human accomplishment through which particular technological constraints and enablements are enacted. Giddens (1984) proposed the notion of structure as the enacted set of rules and resources that inform and enable social action. Applying that notion to the use of technology, the concept of technology-in-use can be understood as the social structure (the set of rules and resources) mobilized by actors in the ongoing and situated use of a particular technological artifact. In this framing, technology-in-use is both the medium and the outcome of situated human action.

Distinguishing between technological artifacts and what people actually do with them in practice is useful because it allows an analytical separation of the potential capabilities of a technological artifact and the capabilities actually mobilized. Thus, we can compare actual use to prescribed or potential use, or trace how the use of a given artifact changes over time or varies by context. Such analyses are not possible where the artifact is conflated with use. Investigations of technology use have tended to concentrate on the artifacts themselves or users' attitudes towards or social constructions of artifacts. While useful, such conceptualizations still do not get at the use of technology in practice. That is where the conceptual lens of technologies-in-use offers a unique perspective.

Whittington (1992:695-6) notes that in Giddens' view, "structures themselves have no reality except as they are instantiated in activity or retained mentally as remembered codes of conduct or rights to resources." In social life, actors do not enact structures in a vacuum; they draw on their knowledge of prior action and the rules and resources that animated those actions, and in this way, apply remembered codes and rights to "structure" their current action. Thus, the structures (rules and resources) enacted by prior human action come to shape individuals' current action, which in turn recreates the structures anew (with our without modification). While actors display knowledgeability and capability in their action, these are not entirely conscious or deliberate. Much

of the knowledgeability and capability of human conduct is displayed "in the vast variety of tacit modes of awareness and competence," or what he calls "practical consciousness" (Giddens, 1981:163). This vocabulary for understanding the structuring of social practices is a useful one for developing a perceptive on technologies-in-use as virtual structures, sets of rules and resources that are realized in human action, informed largely by practical consciousness, and enacted in specific historical and contextual conditions.

The structuring of technologies-in-use suggests that when a technological artifact is introduced into a context, actors develop knowledge and understanding, both explicit and tacit, about the kinds of features offered by the artifact, the sorts of uses to which that artifact may be put within certain contexts of use, and the likely outcomes of such uses. This knowledge is often derived from knowledge of other or previous technological artifacts and prior enactments of technologies-in-use. For example, architects' use of Computer-Aided Design technology often reflects their familiarity with drawing in two-dimensional space, a process afforded by their prior use of pencil and paper. As a result, they may not appreciate the possibility and advantages of drawing in the three-dimensional space facilitated by the new technology. Users' knowledge of an artifact is also influenced by the images and instructions, demonstrations and directions, presented by vendors, champions, trainers, and local management (Orlikowski, et al. 1995). In appropriating the technological artifact in their ongoing action, users constitute a pattern of using the artifact that defines and establishes a particular technology-in-use. This enacted technology-in-use may be understood as the set of rules and resources that structure users' interaction with the artifact in practice. Over time, ongoing enactment of the same technology-in-use tends to reinforce that pattern of use, so that it becomes routinized, an expedient and habitual response to use of the artifact within the daily exigencies of organizational life. The establishment and routinization of particular technologies-in-use within an organization reflects the social tendency towards institutionalization of practices (Zucker, 1977). Once institutionalized, technologies-in-use serve as "behavioral and interpretive templates" (Barley, 1988) for using technological artifacts within the organization.

Institutionalized technologies-in-use, like social structures in general, tend to become reified, and rather than serving as effective guides to action, they may come to be treated as predetermined and incorrigible rules and resources that determine future interactions with the technological artifact. For example, Tyre and Orlikowski (1994) found that early patterns of technology use tend to become congealed and difficult to change subsequently, while Orlikowski (1991) shows how the design assumptions built into a software development tool influenced its users so that they had difficulty conceiving of and developing systems which deviated from the tool's assumptions.

However, patterns of technology use can and do change with time, changing circumstances, and revised motivations. They change through the same process that social structures in general are changed -- human action. Whether deliberately or inadvertently, every time actors use a technological artifact they reaffirm the prior technology-in-use or they modify it. Modifications may result from deliberate adjustments to patterns of use, for example, supervisors requiring workers to engage safety mechanisms during machine operation, or writers creating customized templates in the use of desktop publishing software. Or they may be occasioned by inadvertent slippages or breakdowns, when, either through inattention or error, users fall into a different form of use, such as forgetting to attach safety guards, or halting use of a component because it is unreliable or awkward to use. Changes may also result from improvisations -- situated innovations responding to an unexpected opportunity or problem -- such as when a temporary workaround or experiment becomes regular practice because it turned out to be more effective than the original mode of operation.

Technologies-in-Use: *Rules*

Giddens (1984) defines rules as generalizable procedures constituted in the enactment of social life. This enacted definition of rules departs from our everyday understanding of rules as external, given prescriptions for social conduct that may be formalized in corporate policy (e.g., production orders, safety regulations), legislation (e.g., tax law, traffic rules), or exist informally as in articulated or unarticulated "ground rules" or "rules of thumb." Giddens' rules are also not to be confused with cognitive schemas or "mental structures" as some have suggested (Sewell, 1992). Conceiving of rules as either external prescriptions or mental constructs assumes they have an existence outside of practice, and hence departs from the notion of rules as constituted in action. Taylor, in a recent discussion, critiques these two commonplace (mis)conceptions of rules -- the subjectivist reduction to cognitive phenomena and the objectivist reification:

> We may attribute formulations of the rule as thoughts to the agents. ... [or we may] see the rule-as-represented as defining an underlying "structure." We conceive this as what is really causally operative, behind the backs of the unsophisticated agents, as it were.(1993:55)

Noting that both distort the nature of rules by removing the essential role of agency, he continues:

> In its operation, the rule exists in the practice it "guides." ... the practice not only fulfills the rules, but also gives it concrete shape in particular situations. ... In fact, what this reciprocity shows is that the "rule" lies essentially *in* the practice. The rule is what is animating the practice at any given time, not some formulation behind it, inscribed in our thoughts or our brains or our genes or whatever. That is why the rule is, at any given time, what the practice has made it. (1993:57-58, emphasis in original)

While individuals have knowledge of various substantive or normative procedures, such knowledge does not in and of itself constitute rules because it may not be drawn on in action. For example, individuals may have detailed knowledge of the operations of tabulator equipment (Yates, 1993), or the codes of conduct that prevail among the computer hacker community (Turkle, 1984), but they typically do not use these to inform their contemporary behavior. While knowledge of

tabulator function or hacker custom constitutes part of these individuals' interpretive schemes, it does not constitute rules (in the structurational sense) until that knowledge informs their action.

So it is with the substantive and normative procedures that are built into or prescribe the operation of technological artifacts. Through their design, construction, and packaging, technological artifacts come to reflect and embody specific assumptions, procedures, and knowledge about the world and use of artifacts within it (Noble, 1984; Perrow, 1983; Suchman, 1987; Winner, 1986). For example, automobiles reflect knowledge as diverse as combustion engines and styling preferences, and they embody procedures for appropriate operation (such as, shifting gears with the clutch engaged, not moving with the brakes on or seatbelts off, etc.). When used regularly to facilitate action, the knowledge and procedures embodied within the technological artifact become enacted as rules, as part of the technology-in-use. Not all the knowledge and procedures composing the artifact need be activated all the time (e.g., not using windshield wipers when it's not raining), and not all the knowledge and procedures need be activated intendedly. Further, some of the knowledge and procedures may be enacted differently to that intended by the designers (e.g., driving without engaging the seatbelts). Different actors may generate different rules for their use of a technological artifact and these are likely influenced by their engagement in different social contexts. For example, taxi drivers utilize their automobiles differently when they are "being a cabbie" than when they act as private citizens. The different use practices or technologies-in-use enacted in those different circumstances are also likely to differ from the use practices of ambulance drivers, learner drivers, and drunk drivers. Thus, while the technological artifact in each case may be similar or perhaps even the same, the contexts of its use and the intentions, knowledgeability, and capabilities employed by the human actors utilizing the artifact will vary, generating a variety of technologies-in-use.

When enacted as rules, the knowledge or procedures that are embodied in an artifact, serve as enablements and constraints on users' actions. For example, thousands of Americans annually use a tax preparation software program to complete their tax returns. Knowledge of the Federal tax code, mathematics, and the structure and requirements of various tax forms informed the design of this artifact. As people use the software program, they enact that knowledge as tax reporting rules which enable the creation of various forms (e.g., a "1040 Form") and appropriate accompanying worksheets. Simultaneously, the enactment of those rules constrains these individuals' ability to use the artifact to create alternative tax reporting representations (say a "999 Form"), to follow the procedures of the British tax code, or to calculate the totals in a more "creative" way. Distinguishing between knowledge of rules and rules themselves allows the examination of how knowledge is used (or not used) in the enactment of particular rules in various circumstances, and

when or how enacted rules may deviate from knowledge of rules in practice. For example, when the IRS instituted a change in filing procedures by allowing electronic filing of tax returns, some users changed their pattern of using tax preparation software by performing all the work electronically and then simply downloading the completed electronic "forms" to the IRS computers.

Technologies-in-Use: *Resources*

Giddens (1984:33) defines resources as capabilities or "forms of transformative capacity" that generate command over objects, goods, or material phenomena, and command over persons in processes of structuring. He has also noted (1977:133) that: "By 'resources' I mean whatever [capabilities] actors are able to bring to bear to facilitate the achievement of their purposes in the course of social interaction." The emphasis is on capabilities that are used in practice. It is important that Giddens' notion of resources not be confused with our common-place understanding of resources as given entities -- whether material, financial, or intellectual -- that may stand apart from action. Such an error is easy enough to make (see for example, Sewell (1992)). Giddens' notion of resources, in contrast, is rooted in the use of material, financial, or intellectual entities in practice through which they provide actors with different capabilities in various contexts. Outside of human action, these entities no longer count as resources, as Giddens (1984:33) emphasizes:

> Some forms of allocative resources (e.g. land, raw materials etc.) might seem to have a real existence. In the sense of having a "time-space" presence this is obviously the case. But their "materiality" does not affect the fact that such phenomena become resources ... only when incorporated within processes of structuration.

Akin to rules then, resources are instantiated in human agency.

Technological artifacts embody a range of features, but these are only constituted as resources (in the structurational sense employed here) when they are mobilized in human action. Consider the example of factories. Factories are not resources by virtue of their material existence as so much steel, concrete, and equipment. They only count as resources in the ongoing agency of individuals. In the once-booming US steel and automotive industries, there was a time when steel mills and automobile plants played a dominant role in the production and reproduction of the US economy. At that time, the material properties of mills and plants were used by the men and women who worked in them to generate considerable productive capabilities. Hence, these factories served as important resources in a context and a set of social practices that valued and utilized their productive output. Today, most of the steel mills and many of the automobile plants have been shut down, and these closed factories no longer play a role in the US economy. With their physical properties still very much intact, these mills and plants are no less material phenomena with a particular existence in time and space. But they are no longer resources in structurational terms,

because they are no longer implicated in the ongoing action of human agents; hence, they no longer generate transformative capacity for human action. In a context redefined by global trade and electronic technology, the material stock of these mills and plants is no longer seen as useful by human agents -- at least for the time being. The qualification is important, because conditions can and do change, and a reevaluation of these old mills and plants in the future may again find in their material properties (or some modified version thereof) the opportunity to generate transformative capacity for human action. At that point those factories may serve, once again, as resources if they are drawn on by human agents in concrete social practices.

Distinguishing between the features offered by artifacts and the resources generated in using those artifacts allows us to examine how technological features are used (or not used) in the enactment of particular resources in various circumstances, and when or how enacted resources may depart from those prescribed by developers or implementors, and across time and context. For example, the simple technological artifact, the hammer, can be used by a carpenter making a chair, a construction worker building a condominium complex in the suburbs, an auto mechanic panel-beating a fender back into shape, and a sculptor chipping away at stone to produce a piece of art. In these various uses, the same technological artifact becomes a resource generating a variety of capabilities for action. Indeed, a hammer may even generate useful capabilities for my action. Most of the time a hammer just lies, buried and half-forgotten in the bottom of my kitchen closet and as such does not serve as a resource in my ongoing activities. But there are some situations when its material properties will come in handy and on those occasions -- when I use it to take action in the world such as hanging a picture on a wall or arming myself against an unwanted intruder -- that hammer becomes a resource. Thus, across time and a diversity of places -- the woodshop, the construction site, the garage, the art studio, and my home -- a particular technological artifact, the hammer, is implicated in the production and reproduction of multiple and various social practices -- furniture making, building construction, automotive repair, art, home improvement, and self-defense. In these various uses of a single technological artifact, a range of technologies-in-use can be enacted, some anticipated by its developers, others not.

Technologies-in-Use: Rules *and* Resources

While the above discussion has consider rules and resources separately, in practice they are inherently and reciprocally dependent on each other. The manipulation of resources always involves both substantive and normative aspects of knowledge, while, resources provide the means by which these substantive and normative rules are actualized (Cohen, 1987:287). As structures, technologies-in-use are produced, reproduced, and sometimes modified in the ongoing enactment of rules and resources through mobilization of knowledge and capabilities. And the kind

of technology-in-use that is generated depends on the features of the artifact, the knowledge and intentions of the actors, as well as historical and institutional conditions. While the carpenter, auto mechanic, and sculptor all use a hammer in their work, the technologies-in-use they generate -- the particular rules and resources that structure their action -- are very different, as are the outcomes of that use. And it is in these differences between a given artifact and its various uses by different actors across contexts and time, that the creative and transformative aspects of technology as practice lie.

INVESTIGATING TECHNOLOGIES-IN-USE

Investigating the structuring of technologies-in-use requires the identification and collection of data on the technological artifact in question, the knowledge users have of the artifact, the institutional contexts of use, and the actions taken by users with the artifact. These data can then be analyzed to identify patterns of use which embody particular rules and resources, and the consequences, intended and unintended, of such patterns of use. The intent in the analysis is to examine whether and why users' social practices involving a particular technological artifact result in the enactment of different technologies-in-use, and what the organizational implications of such practices are. Giddens (1979) suggests that an explication of virtual structures requires examining actors' knowledge (memory traces, whether explicit or tacit, of "how things are to be done"), their social practices (organized through the recursive mobilization of that knowledge), and the capabilities implicated in the production of their practices. Likewise, the virtual technologies-in-use may be investigated by examining those social practices that involve technological artifacts, and the relevant knowledge and capabilities used by actors to accomplish those practices.

The technological artifact can be examined by interviewing the artifact's key designers and promoters and probing on their motivation and intentions for the artifact, their design approaches and decisions, as well as the influences on these choices. As Suchman (1983:3) points out: "Every human tool relies upon, and reifies, some underlying conception of the activity that it is designed to support." It is that underlying conception of the activity that is of interest when interviewing tool developers. The documentation accompanying the artifact's production, packaging, and promotion, as well as any instruction manuals can also be analyzed. Observation of the artifact in operation, further provides materials for characterizing the features and functionality of the given artifact. DeSanctis and Poole (1994:126) suggest examining a technology's "feature set" as a way of identifying the "social structures provided by an advanced information technology." However, they do not differentiate between technological artifacts and technologies-in-use, and hence imply that social structures are embodied in given artifacts. The perspective presented in this paper posits instead that the feature set of a given artifact provides some of the potential capabilities that actors

invoke as rules and resources in their enactment of technologies-in-use. A number of dimensions for characterizing the feature set of an artifact have been proposed (DeSanctis and Poole, 1994) and one or other of these may be followed, or dimensions may be constructed from the data. The intent is to describe those features that are generally available as potential capabilities to be drawn on by users in their action, rather than exhaustively characterize every aspect of the artifact.

The enactment of technologies-in-use depends on the knowledge that users have of the artifact and their institutional context, their motivation and skills in applying that knowledge, and the conditions of their action. The repeated enactment of a technology-in-use depends on knowing what is possible (technical feasibility) and what is useful, effective, and appropriate (institutional feasibility) within a particular context of use. Users' knowledge of technical and institutional feasibility may be explored by seeking data on users' technological frames (Bijker, 1987), which Orlikowski and Gash (1994) define as the assumptions, expectations, and knowledge that organizational members draw on to understand and use technological artifacts in their work. This includes not only the nature, role, and functionality of the artifact itself, but the specific conditions, applications, and consequences of its use in particular contexts. Some aspects of technological frames are part of users' discursive consciousness, and others are tacit, part of their taken-for-granted practical consciousness.

As knowledgeable, reflexive actors, users have motivations and intentions for taking certain action, even if these are not always realized, or realized as intended. Such actions also, inevitably, produce unintended consequences. Skills in using a technological artifact are usually influenced by knowledge, cognitive ability, training, and experience, and are particularly relevant in the enactment of certain and different technologies-in-use. Knowledge of the artifact by users can be obtained by observing users' interactions with the artifact, and interviewing them about their understandings of the artifact and its functionality. Actions taken by participants towards the artifact can be studied by direct observation as well as by interviewing participants about their actions and intentions. The latter approach may be quite informative, as Giddens (1993:92) notes: "... given that [an actor] is not dissimulating, her or his testimony as to the purpose and reasons for her or his conduct is the most important, if not necessarily conclusive, source of evidence about it." The institutional context of use can be investigated by focusing on dimensions of the workplace that embody the rules and resources guiding action, such as tasks, division of labor, norms, incentive systems, roles, and control mechanisms.

The value of the technology-in-use perspective became particularly apparent after I had completed two field studies into the implementation and use of a particular technological artifact, the *Notes*®

software product ([cites suppressed]). The range of technologies-in-use enacted with this same artifact both across as well as within the organizations highlights the value and importance of the technology-in-use perspective proposed here. Some of the technologies-in-use varied considerably from designers' or implementors intentions, some varied by context and over time, and others involved innovation around the prescribed features. Such uses and their associated organizational outcomes would not have been predicted by an examination of the artifact in question or users' constructions of it. Before examining the technologies-in-use enacted with the Notes artifact, a discussion of the artifact is appropriate.

Technological Artifact: *Notes*

Data about the technological artifact were collected by interviewing its chief designer and two individuals involved in its product development. All three interviews lasted just over an hour in length and were largely unstructured in format to allow for open-ended discussion about the technological artifact. Further information about the artifact was obtained from product descriptions and promotional materials provided by the vendor, as well as trade reports published by software reviewers. I also had access to the artifact itself, and could examine its espoused features and prescribed functionality.

The Notes technological artifact differs from typical organizational software products which are intended to support either transaction processing (such as order entry and inventory systems), or individual work (such as spreadsheet or word processing programs). Notes represents a class of software product that has come to be known as "groupware," where the intent is to support the work of groups by facilitating discussion, information exchange, and collaboration across time and space. The CEO of Lotus noted in a speech in 1991 that groupware and Notes, represent "a shift from notions of information processing to information sharing," which provide "a new paradigm for computing in the nineties." The intellectual roots of this new type of organizational computing are located in the research community of computer and social scientists who, in the early eighties, began studying what they call "computer-supported cooperative work".

The Notes software operates on personal computers connected to local area networks, and the capabilities it provides are communication tools (via electronic mail and bulletin boards), document management (via shared databases), security (via public key encryption of electronic information), and application development (through customization of existing database templates, or construction with a built-in programming language). The major features of the artifact as espoused by its developers are summarized in Table 1. Notes requires both a "client," the software which runs on each users' machine and which offers a graphical, tailorable, icon-based user interface, and the

"server," the software which runs on the network and manages the communication among users ("clients") and their shared access to databases and bulletin boards maintained within the Notes environment, both locally and remotely (see Figure 1). The Notes product is sold and distributed by the Lotus Development Corporation, but it was developed by a small organization working with funding from Lotus. The founder of the firm and chief architect of Notes, was Ray Ozzie, a former employee of Lotus. My data revealed a number of influences on the design and construction of the Notes artifact: historical, institutional, and market.

Historical influences. The origin of the Notes artifact has roots in the Plato system at the University of Illinois at Urbana-Champaign. While a student of computer science in the seventies, Ozzie was exposed to the Plato system, a mainframe-based computing environment on the Illinois campus developed by researchers to test the feasibility of on-line tutoring systems. Technically, the Plato system was ahead of its time with graphical, interactive interfaces and communication software which facilitated campus-wide computer conferencing. Written by a local systems programmer and known as Plato Notes, the communication software made a big impression on Ozzie, as he recalled years later:

> The [Plato] Notes tool was created to help systems programmers communicate with each other. But I saw other people, people who had no knowledge of computers, using this tool to collaborate on projects, to interact, to establish relationships with other people, people they had never seen or met. It was amazing.

After graduating and working in the software industry for a number of years, Ozzie returned to the communication capabilities that had so influenced him in Illinois:

> In the early 80s I was working in spreadsheets, but spreadsheets didn't turn me on. So my mind turned to Plato and what I had experienced there -- collaboration and communication. I wanted to start my own company to develop those things.

This prior exposure to and experience of a mainframe-based "groupware" functionality clearly shaped Ozzie's mental model of the kind of technological capability that could be provided, and why and how it might be useful. He indicated that his vision for the Notes artifact came from the simple and single idea of providing a tool that would support collaboration among individuals. He believed that such a tool could be useful more broadly, although admits that at that time he did not have any real evidence for this belief:

> My vision came from the fact that I saw lots of people in little research groups collaborating across the world with this tool. ... I had never really worked in a corporate culture and did not understand the dynamics of a business, and how people worked in them. But I knew that great things would happen if they communicated and talked to each other.

Ozzie started his own company in 1984 with financing from Lotus Development Corporation. He hired four colleagues, two of whom were college buddies who had also experienced the Plato system. The five developers then spent a number of years (from 1984 to 1989) designing, building, and testing the Notes artifact. While funded by Lotus, the team retained creative and

technical autonomy, designing and building the Notes product from the blueprint developed by Ozzie in 1984. Most of the critical design decisions had been determined early, as Ozzie explained:

> I had a high-level idea of what I wanted to do. ... I had envisioned Notes to have such functions as conferencing, word processing, mail, and so on. ... So from day one, it had a graphic user interface, client server architecture, and public key cryptography. So all the major design decisions were made before we started.

The inspiration for the functionality of the Notes artifact was clearly Plato Notes, with the ideas for the technical implementation coming from some of the other computing platforms the five designers knew about or had experienced in their years since college, as Ozzie noted:

> There is virtually nothing unique about Notes. My highest level goal of the utmost user collaboration came from Plato. The architectural foundation came from personal computers and networks, that is, local-area networks from Data General and PC's from Software Arts.

Notable in the inventors' view of Notes, is a lack of specificity about the ways in which the tool would be used in organizational settings. Ozzie commented that:

> The product as shipped was essentially the creative vision of the founders. We still had not participated in real businesses, so we didn't know what they [organizations] would use it for.

Institutional influences. Many of the design decisions that were made in the construction of the Notes artifact were strongly influenced by the values and norms of the five-person development team, and the kinds of work processes they had established. As these five individuals created the Notes artifact, they were also creating an institutional context, and many of the norms and procedures established for their company also informed their product development work, and were embodied in the artifact. Ozzie explained that they deliberately created a software development context which was different from that of many technological production environments:

> As a group of individuals we share the same beliefs about how we'd like to see people work -- the Iris values. We implemented a very different software development methodology here that relies on distributed management, distributed security, and distributed development. ... It's an anarchistic model of source code management which we deal with by having tools that resolve conflict among us. Centralized management is something that is counter to how we feel, to our philosophy.

This philosophy of decentralized control enacted within the Notes development environment is strongly reflected in all aspects of the Notes artifact, which has a highly distributed architecture. One of the features of the artifact is the ability for users to create customized applications which utilize the underlying Notes functionality. As Ozzie notes, the capability to "build" applications was extended to any user, in conformance with the overall design philosophy of the developers:

> A design debate we had a lot was does every copy of Notes have the ability to design applications or do we have a developer's copy and user copies? In practice, while it is a nightmare for the MIS person to have this [design] capability on every copy of Notes, it makes the product more exciting for the users because anyone can turn from a user to a developer overnight. We wanted individuals to have independence over their work. Distribution is a value that pervades our philosophy. So technically and architecturally the product [Notes] embraced distribution.

Market influences. Because the notion of groupware was not well established in the late eighties, Lotus, who assumed responsibility for marketing and selling the Notes product, struggled to put a label on the artifact that would convey its functionality to prospective users. As Ozzie recalls:

> [Lotus] thought Notes was a good idea. But they had no idea of how to sell it. ... One person on the Lotus project review team for the product -- from Marketing -- said "I don't like it because I don't know how to sell it." He was right. It did not look like a shrink-wrapped product.

A number of Notes supporters within Lotus decided to get some early customer feedback on the product, so they set up a group of some 30 customers to test the product. These early customer responses helped significantly to define the artifact, as two product managers recalled:

> We held a round table session in the first quarter of 1989 -- customers, developers, marketing people -- all sitting around talking about the product. It was unusual to do that at Lotus. We were all looking for the sound bite. [One senior executive] had a great insight. He said "Let the customers define your product for you. Tell the world what the first customer says it is. Let the market position it for you."
>
> We went around and talked to these [test] customers -- we saw them as our "design partners" -- and got their feedback. Then we incorporated their ideas and feedback into our presentations at the next customer. Maybe this was cheating, but it was an iterative definition of the product.

This decision to "let the customer define your product" generated a better understanding of what the artifact might be useful for in the market. Ozzie admits:

> I have been educated. I am an engineer by trade. I didn't go to business school. If I had, I would have understood better what I was building.

Customer participation in product definition also generated much interest in Notes among these early beta sites, and many became official customers once the product was launched in late 1989.

As an artifact, Notes was designed and constructed by a group of computer designers, to implement in a personal computer environment the capabilities of document sharing and electronic communication that had previously only been available in a mainframe environment. It was deliberately designed to embody a decentralized architecture and allow ongoing user adaptation to the artifacts. Its positioning in the marketplace was influenced by a number of factors, most importantly the growing interest in and spread of local area networks, the academic interest in computer-supported collaborative work, and key customers experiences during beta testing. The definition of Notes as groupware, as a new paradigm of organizational computing was clearly a social construction -- a marketing strategy to differentiate the product from other artifacts such as spreadsheets and electronic mail systems, and to position it as a strategic product for organizations operating in global, team-based conditions.

Enacting Technologies-in-Use with the Notes Technological Artifact: *Alpha*

I studied the implementation and use of the Notes artifact within a large, multi-national consulting firm (here known as Alpha). Alpha has offices in hundreds of cities around the world and employs over 10,000 consultants who work on project engagements within a matrix operating structure to deliver professional services to clients. In the late eighties, a Chief Information Officer (CIO) position was created with responsibility for Alpha's global use of information technology. Having been recently exposed to the Notes technological artifact, the CIO was persuaded that it offered the functionality to not only provide corporate-wide electronic mail support, but also to facilitate

electronic discussions and knowledge sharing. These capabilities, he believed, would address the considerable "reinvention of the wheel" which occurred within Alpha when consultants in different offices worked on similar client problems without sharing knowledge, approaches, or solutions, and thus duplicating effort and not leveraging the existing expertise and experience of the firm. The CIO purchased thousands of copies of Notes for Alpha's consultants, and ordered his staff to install it (and the supporting infrastructure of hardware and networks) quickly in all offices, so as to achieve a critical mass of users as soon as possible.

My study within Alpha was conducted in 1991, about a year after the firm's acquisition of Notes. A five-month field study was concentrated within one large practice office (see [cite suppressed] for more details). Data collection included interviews, document review, and observation of meetings, work sessions, and training classes. Participants spanned all four of Alpha's hierarchical levels (junior consultant, senior consultant, manager, and principal), included some administrative and technology support personnel. The data collected at Alpha were analyzed by careful reading and recursive coding to identify how use of the technological artifact reflected and shaped the rules and resources enacted in such use. A qualitative approach was used to analyze the data in terms of the categories of interest identified above. Because technologies-in-use, as social structures, are virtual, they cannot be directly observed, and must be inferred. Data about participants' actions, complemented by data about participants' knowledge of the artifact, their intentions, motivations, as well as their institutional context of use, grounded the inferences about the kinds of technologies-in-use being enacted.

Consultants working on client engagements performed a range of managerial and technical consulting services, some standardized and routine, some unique and research-intensive. Most of the actual work was done by the junior and senior consultants working at clients' sites, with managers and principals providing supervision and managing client relations from the office. All the consultants were, to a greater and lesser extent, influenced by (and in turn, reinforced) the Alpha institutional context within which they worked. The dimensions of the institutional context held different salience for different consultants, depending on status, role, tenure, and individual differences. Four distinct types of technologies-in-use characterized the interaction of Alpha consultants with the Notes artifact (see Table 2). The first of these--*technological shunning*--is essentially a pattern of nonuse where users choose not to use the artifact at all. The second--*technological skepticism*--is a pattern of use where users doubt the artifact can provide any benefits, so they attempt only limited and half-hearted uses of its capabilities. The third--*technological substitution*--is a pattern of use where users utilize the artifact to perform electronically what had previously been done in other ways, for example, distributing memos

electronically rather than on paper or sending electronic mail instead of voice mail or faxes. The fourth--*technological exploration*--is a pattern of use where users are interested in using the artifact in their work, but their use is wary, short-lived, and episodic, either because they lack necessary skills and knowledge or because they are concerned about the consequences of such use within their institutional context. Let us look briefly at each in turn.

Technological Shunning

For consultants engaging in the technological shunning pattern of use, the institutional features of their context were particularly influential. Alpha's governance structure -- a partnership -- with its attendant "up or out" career path which controls progress of all consultants via four primary milestones influenced consultants to act competitively. This competitive culture was felt most keenly by senior consultants and managers anticipating the partnership hurdle, and they believed that their use of Notes would hurt, not help, their chances of promotion. For example:

> Power in this firm is your client base and technical ability. ... Now if you put all this information in a Notes database you lose power. There will be nothing that's privy to you, so you will lose power. It's important to me that I am selling something that no one else has.
>
> In Alpha we have a lot of problems getting people to share expertise and information. That is not in the culture. ... People hide information because it gives them an edge.
>
> I'm trying to develop an area of expertise that makes me stand out. If I shared that with you you'd get the credit not me.
>
> The corporate psychology makes the use of Notes difficult. Particularly the consultant career path which creates a back-stabbing and aggressive environment. People aren't backstabbing consciously, it's just that the environment makes people maximize opportunities for themselves.

For many consultants, use of Notes in an environment of competitive individualism -- which reinforced individual effort and ability, and did not support cooperation or sharing of expertise -- meant risking their expertise and status. As a result, they chose not to use it.

Other consultants engaged in technological shunning as a response to billing practices. For all consultants except principals, there was an expectation within Alpha that most if not all hours should be "chargeable," that is, billed to clients and hence revenue-producing. Consultants were evaluated on how many "below the line" (i.e., nonchargeable) hours they incurred and most consultants studiously avoided having any.[1] Because many of the consultants did not perceive using Notes as an activity that could be billed to clients, they were unwilling to spend time on it, either to learn or to use the product, as this meant either incurring "nonchargeable hours" or giving up personal time. For example:

> I am not sure seniors have time to learn or use Notes. ... As a senior on an engagement your entire time is chargeable. You're not entitled to charge nonchargeable hours.

---

[1] Even though they had been told to charge their time I spent interviewing them to a professional activities code, many consultants confided that they would "swallow the time" so as to avoid any dreaded "below the line" hours.

> Intellectually I understand the need to use something like Notes, but when we make an investment in Alpha to learn systems or technology usually that is not a chargeable hour, that is, it is "below the line." But it is a chargeable hour I could have spent elsewhere. ... Seniors and managers never have nonchargeable hours. It's just not done. It doesn't happen.
>
> We don't have the time to read or enter information in Notes. What would I charge it to? We already complain that we can't charge our reading of our mail to anything. We end up having to charge it to ourselves [he reads his mail on the train going home].

While the acquisition of Notes and its attendant technical infrastructure was decided by the President and CIO, the spending of time and money on training and application development was left to the discretion (and budgets) of individual principals in local offices. One principal, a more enthusiastic Notes supporter, reported frustration at his more reluctant colleagues:

> One of the biggest problems we have here is turf battles, i.e., keeping score by office and department. So people get protective of their time and resources and don't want to spend money on training or database development.

Evaluation criteria of consultants were not amended to reflect use of the Notes artifact, and consultants were not rewarded for using the Notes artifact. On the contrary, some were negatively affected when their use of Notes incurred "non-billable" hours and implied loss of some unique competence. Thus, consultants' enactment of the technological shunning pattern of using the Notes artifact was strongly influenced by the firm's institutional context with its partnership structure, competition, individual evaluation criteria, incentives, norms, and time-based billing practices. Such a pattern of use, in turn, served to further reinforce the firm's existing institutional context.

Technological Skepticism

A pattern of technological skepticism was enacted by consultants who had doubts about the value of the artifact in their work and whose use of Notes consequently remained limited. The technology-in-use reflects a lack of conviction by the users that the artifact could improve either their personal or the firm's performance. Some of these consultants were skeptical about technology in general and applied this same skepticism to the particular case of Notes, as in this principal's reaction:

> I first heard about Notes when I read in the Wall Street Journal that Alpha had purchased a revolutionary new piece of software. My first thought was -- how much is this costing me personally? ... this kind of implementation affects all of our pocketbooks. ... I have [heard that] there is no value in information technology -- so you can imagine how I feel!

and that of a manager:

> My workstyle is heavily interpersonal and oral. So far computers have not really saved me time. I am not interested in doing all that protocol stuff to get access. I don't want to deal with a programmer's conception of the world. ... I approach Notes with the attitude "Do I really need this?" ... I see computers as black and white, and so as not really suitable to my work.

Others based their skepticism on an assumption that the Notes artifact primarily facilitated static or unreliable information transfer. For example:

> I don't believe that Notes will help our business that much, unless all of our business is information transfer. It's not. Business is based on relationships. Ideas are created in non-work situations, socially, over lunch, etc. People misreport information in databases; a few phone calls are worth more. Most of the stuff on Notes is junk mail. Anything important comes over the phone. I am very skeptical of the value of Notes.

A vivid illustration of user skepticism occurred a few days after I had interviewed a manager. Arriving to work in the morning, he sought me out, commenting: "The other day you asked me what I thought of Notes. Well, here's your answer." He then handed me a cartoon he had clipped from that morning's newspaper (see Figure 2).

Consultants who enacted the technological skepticism pattern of using the Notes artifact often had limited knowledge of the artifact's capabilities, even after taking the hands-on training class, watching the half-hour video, and receiving copies of users' guides. None of these training options emphasized the collaborative capabilities of Notes, and did little to illustrate how Notes could be used in consulting practice. The training sessions and materials were technical, non-specific in content, and dealt with the mechanics of using the software individually, for example, how to utilize functions such as electronic mail, text editing, and database browsing. Most consultants found the training less than helpful. One manager referred to it as "condescending," while another noted: "Training here is so basic it doesn't tell you much." Many consultants had not referred to the users' guides, which often lay, still shrink-wrapped, in the corner of their offices. The particular mental model consultants developed of Notes as a result of the training sessions and materials, encouraged some of the skepticism and disinclination to spend much time using the artifact. While these consultants occasionally used Notes, their skepticism and lack of enthusiasm qualifies their use as little more than dabbling. Of the consultants that I shadowed, half enacted this technological skepticism pattern of use, and on average, used Notes for two minutes a day -- merely to check their electronic mail. A comment from one principal captures the sense of this pattern of use:

> At this moment I use Notes less than five minutes a week ... I look at it when I am on the phone, to kill time when I am bored.

Consultants' enactment of the technological skepticism technology-in-use were strongly influenced by their prior experiences with information technology and their mental models about what such artifacts could accomplish in practice. The process of implementing the Notes artifact within Alpha did not offer counter-examples and did not help consultants' change their mental models. The lack of work and context specificity to the training and applications only served to further reinforce these consultants' prior skepticism, and created the notion that this artifact was merely "a solution in search of a problem."

Technological Substitution

The third type of technology-in-use identified among the consultants involves use of the artifact to substitute for some existing ways of doing things. This technology-in-use is a common response

to unfamiliar technological artifacts. As Barley (1988:50) notes, there is evidence that "workers attempt to assimilate new technologies under previous patterns of practice and interpretation." In the absence of new interpretations and routines, actors often deal with new technological artifacts by applying existing cognitive frameworks to make sense of them, by subsuming use of the artifacts within established routines, and employing the artifacts to solve existing problems.

In the case of Alpha, a number of consultants and administrative staff began to use the Notes artifact for activities they had previously conducted in other media. For example, they began distributing memos electronically rather than on paper, sending one-to-one or broadcast electronic mail messages rather than leaving voicemail messages, and transferring files to other offices rather than sending faxes or using express mail. Some managers also browsed Notes databases to read electronic newsfeeds from Reuters and industry newsletters. Users enacted this technology-in-use conceived of Notes in familiar terms,

> I see Notes as a personal communication tool. That is, with a modem and fax applications I can do work at home or at a client site and use Notes to transfer work back and forth. In the office instead of getting my secretary to make 20 copies of a memo, she can just push a button.

and found familiar uses for Notes in their everyday activities:

> I use Notes a lot to look up the [consulting topics] index. It used to be a pain to use it before as you used to have to get up and walk over to another computer. I never bothered to do it and would get my staff to do it. Now I can just access it from my Notes menu.
>
> I send Notes [electronic mail] when I really don't want to talk to some people. I have no time for niceties or phone chatter, but I want them to get my point and Notes leaves a paper trail.

The technological substitution pattern of use was compatible with the firm's existing institutional context because by automating existing tasks it did not risk violating norms of individualism and time-based billing practices. Users utilized the artifact as a filing cabinet, a distribution channel, and communication medium, and did not attempt to substantially change their work practices with it. The technological substitution pattern of use typically provides incremental improvements in existing ways of doing things; it is less likely to produce significant organizational changes.

Technological Exploration

The final pattern of use involved consultants who were interested in the possibilities of using Notes more centrally in their work, but were cautious in doing so. While they were willing to experiment with alternative capabilities, they struggled to fully integrate use of the artifact into their work practices. In contrast to the users who saw the firm's competitive institutional context as a barrier to using Notes (and hence engaged in technological shunning), the users enacting technological exploration saw Notes as an opportunity to avoid expectations of reciprocity and to promote themselves within the competitive institutional context, for example:

> The value of Notes is that it allows access to information without having to confront individuals, or deal with the quid pro quo stuff that goes on in personal exchange of information.

> I want to be able to share more within Notes. ... to the extent you make an impression, people will recognize you're a [domain] expert and will call on you more. That will make you more visible. If you're a hotshot but no one knows it, that doesn't help you.
>
> Things on Notes have authorship and that allows you to disseminate your expertise further than you normally would. I think that could be a plus.

Realization of these opportunities, however, remained difficult because users continued to be puzzled about aspects of the artifact and conditions of its use. These puzzles were not borne of skepticism but from uncertainty about how the technology works in practice, and ambiguity about the consequences of its use. One significant issue concerned questions of liability, both personal and corporate. Principals, in particular, were worried about the disclosure of corporate information, client confidentiality, and perceptions of unfair billing practices, for example:

> We need to worry about who is seeing the data. ... Managers should not be able to access all the information even if it is useful, [e.g.] financial information to clients, because they leave and may go work for competitors.
>
> Client confidentiality is an important issue. The tension is between revealing something about a client that you should not have, and keeping other people informed about what you are doing. ... There are no safeguards currently in force to deal with this in [Notes]. That is why people are so gun-shy of using Notes.
>
> What happens if work is repackaged and sold to other clients. ... Clients may have a problem if they know that a report or the expertise that they paid for will be made available to others. There may be a double standard going on in the firm. We talk a lot about sharing expertise but we have real client service issues which we don't talk about.

Managers and senior consultants were also anxious about personal vulnerability or embarrassment:

> I would be careful what I put out on Notes though. I like to retain personal control so that when people call me I can tell them not to use it for such and such. But there is no such control within Notes.
>
> There is a hesitancy here because you don't want to put everything into public information as people may rely on that information and screw up, and it may reflect badly on you.

These comments reflect users' recognition of the lack of guidelines, policies, and procedures for using the new technological artifact. While discerning this, they seemed unwilling or unable to take the initiative to resolve some of the open questions. The CIO had deliberately chosen not to define new organizational policies for data quality, confidentiality, and liability, seeing this as outside of his jurisdiction:

> We have a relatively open environment in the firm, so we leave privacy and security up to the local people. ... As Notes, we're a common carrier; we make no guarantees about data quality.

Contrary to the CIO's expectation, neither the management of the HQ nor that of the local offices, had devoted time and attention to these issues, hence provoking unease about the nature and locus of responsibility and liability with respect to the intellectual content and confidentiality of Notes documents. This significantly contributed to some of the cautious interaction and tentative experimentation apparent around the Notes artifact.

The technological exploration pattern of use, in contrast to all of the previous three technologies-in-use, has the potential to produce interesting and innovative changes. In this technology-in-use, users are not attempting to reproduce established ways of working, but are willing to explore

alternatives to it, albeit carefully and with some trepidation. While users' puzzles and concerns remained unresolved, however, this technology-in-use continued to be stalled.

Summary of Alpha's Technologies-in-Use

In these four technologies-in-use enacted by users in Alpha -- technological shunning, skepticism, substitution, and exploration -- we see different patterns of use that have emerged around the same technological artifact. Of the four patterns of use identified, none could be said to realize the CIO's intention of "leveraging expertise," and only the last has the potential -- if as yet unrealized -- to fulfill the promise intended by Notes developers that their artifact would "facilitate collaboration." A strong influence on the four patterns of use evident here is the institutional context within which Alpha consultants work and which constitutes their rules and resources for acting. In the absence of motivation to depart from or change this institutional context, consultants reinforced it in their use of the new technological artifact, thereby not taking advantage of the artifact's potential capabilities to modify their work practices. A different scenario emerged in another company that adopted the Notes technological artifact.

Enacting Technologies-in-Use with the Notes Technological Artifact: *Zeta*

I studied the implementation and use of the Notes artifact within the customer support department (CSD) of Zeta, one of the Top 50 software companies in the US, with $100 million in revenues and about 1000 employees. The company produces and sells a range of powerful software products providing capabilities such as decision support, executive information, and marketing analysis. Zeta is headquartered in the Midwest, with sales and client service field offices throughout the US and the world. Customer support at Zeta involves providing technical support via telephone to clients, consultants, client service representatives in the field, and other Zeta employees. The technical support provided by customer support specialists is a complex activity, typically involving several hours of research including searches of reference material, attempts to replicate the problem, and review of program source code. The department employs about fifty specialists, and is managed by a director and two managers.

In early 1992, the CSD purchased the Notes artifact and developed an application, the Incident Tracking Support System (ITSS), within it to help keep track of customer calls. Following a successful pilot in the latter half of 1992, the CSD deployed ITSS throughout the department. The acquisition of the Notes artifact was motivated by a an expected increase in customer calls due to a growing customer base and an expanding product range. The existing home-grown call tracking system was inefficient, poorly used, had questionable data quality, and provided little support to either the specialists doing problem solving or the managers trying to manage the resources of their

department. Replacing it became a priority and after a feasibility study of a number of products, the Notes artifact was selected. Data was collected in two phases at Zeta, during the pilot and initial implementation to the entire department (August - December 1992), and two years later (July - December 1994). Interviews, observations, and access to documents and Notes databases provided a range of qualitative data which was used to understand the use of the Notes artifact within the CSD (see [cite suppressed] for more details).

Two different types of technologies-in-use characterized the interaction of Zeta support specialists with the Notes artifact (see Table 3). The first of these -- *technological facilitation* -- is a technology-in-use where users appropriate the artifact to support their work practices. The other -- *technological improvisation* -- is a technology-in-use which involves use of the artifact in response to unexpected breakdowns, exceptions, slippages, or opportunities within the workplace. The enactment of these two technologies-in-use within Zeta's CSD was complementary, in that when the specialists enacted technological improvisation they did so to help their technological facilitation. In contrast to the Alpha consultants, who largely enacted only one of the technologies-in-use identified, most of the Zeta specialists engaged in both patterns of interacting with the Notes artifact, often in parallel.

Technological Facilitation

The technological facilitation pattern of use is enacted by users making extensive use of the technological artifact to mediate their work practices. Such mediation involves performing electronically a considerable portion of the work practices, both prior tasks as well as new or modified ones. In the case of the support specialists, their work practices as mediated through the use of ITSS both resembled and departed from their prior work practices. Specialists used ITSS to record every call they took, to maintain an extensive incident history of each call as they worked on it, and to record the final problem resolution when the closed the call. The use of Notes to create detailed process documentation was seen by the specialists as more work, but also understood to help them keep track of work done, to showcase good work, and reuse knowledge:

> Everything is much more organized now and there's an audit trail of everything that's done which eliminates a lot of the gray area where the client said they did this and we didn't do that. We can always prove that we did do that and a lot less slips through the cracks.
>
> Putting in the steps is useful because it lets the managers know what we've done, and it's a fallback if the client says we haven't worked on it.
>
> Of course, the entry is just a pain in the neck. But I know in the long run I'd benefit from it ... I find that the more explicit I was earlier the more it helps me remember when I got back to work on the incident. It gives me a detailed record of what steps I have already performed. It gives you mental feedback.

The detailed process documentation provided both an increasing and an increasingly valuable knowledge base (from about 4,000 records in December 1992 to 35,000 in December 1994),

which specialists searched in order to reuse prior knowledge on current problems. Specialists reported resolving up to 50 percent of their problems through a search of the ITSS database. Searching ITSS was helpful not just because it revealed potentially reusable problem resolutions, it also provided a detailed trace of the work process involved in resolving different types of incidents, which included as a specialist noted: "... all of the history involved, who you contacted, when, what you discussed, how you went about trying to pursue the call ... it's all recorded, and you just need to look at it. It's all in the system." This was seen as beneficial by the specialists, both to others and themselves, for example:

> There are some people whose incidents are books as you read through them. Which is great actually because they become great resources. Because it is all there, all the thought processes.
>
> The history of the calls in ITSS is very helpful ... you kind of look through the people you know and their incident histories to see if there was anything else that they tried in resolving the call. It's much more valuable than just looking at the resolutions.

Specialists also used ITSS to transfer calls to each other, a dynamic distribution of work enabled by the shared database and communication capabilities of the Notes artifact. This electronic distribution of calls was reinforced by a shift in the department's structure from an undifferentiated team of specialists to a front line of junior specialists and a back line of senior specialists. Junior specialists now took all the calls and transferred the more complex ones via ITSS to their senior colleagues in the back line. This took much of the pressure off the junior specialist, for example:

> It makes it, you know, easier, because if you're on the phone and you know that it's a real busy day you don't have to worry, "Oh god, how am I going to able to solve this major crisis, and plus take all these other calls that are coming in?" So it reduces the level of stress that people have, because you don't have to worry about it. If you can't handle it, you pass it.

The technological facilitation technology-in-use utilized many of the features of the Notes artifact -- electronic text entry and edit, database searching, document management, and electronic communication. The enactment of this technology-in-use was facilitated by a number of aspects of the Zeta and CSD institutional context. The definition of the specialist job had been changed since the deployment of the Notes artifact to include use of ITSS as the mechanism for entry of calls, documentation of process, and recording of problem resolution. Evaluation criteria employed by the CSD managers focused on specialists' use of the Notes artifact to enter and document their calls, the technical problem-solving skills evident in the incident histories, and the quality and quantity of problem resolutions. The structural division of labor among junior and senior specialists further influenced specialists in their sharing calls among each other. Sharing of calls and electronic communication via e-mail reflected the cooperative culture of the CSD, as reflected in these comments:

> It's a very cooperative group, it really is. ... This is a very comfortable environment. There is no sense of right or wrong. We all realize that nobody's expert in everything. ... You have to work it as a team.

> Here, I don't care who grabs credit for my work. You know, it's like we're all the support department. We're not just individuals, you know. This support department does well because we're a team not because we're all individuals.

Technological Improvisation

A second technology-in-use was evident in the specialists' interactions with the Notes artifact, and it involved action they took to deal with unexpected problems or take advantage of unanticipated opportunities. Such action went beyond the prescriptions of the ITSS application and typically generated workarounds, new norms, or modified procedures to correct or improve the work. A number of examples illustrate this mode of interacting with the artifact. One concerned the expectation that specialists would directly enter into ITSS the details of each call while on the phone with the customer so as to provide an up-to-the-minute record of all calls being received in the department. Many specialists, however, found real-time entry of calls too difficult and developed a practice of bypassing this requirement by jotting down details of a call on paper during the phone conversation and then entering them into the ITSS database at a later time. The rationale for this practice was grounded in specialists' concerns about their typing skills and the nature of listening and comprehending complex, technical problems. For example:

> If you're not confident in your typing skills, there's just no way you're going to put a call in online.
>
> When I take a call I always write it out. And the reason for that is I can't type and listen at the same time. I can write and do it. But I think because I'm trying to listen and type, it just screws me up. ... I have to think while I'm typing.
>
> I'm not comfortable typing in the incident as they're telling it. I find it's more of a distraction. I'm trying to figure out what piece of the form to fill in and they're talking rapidly about a problem, so my concentration is split and I find myself not being able to ask the right questions or forgetting some piece of information.

Another example of technological improvisation arose around the giving of help among specialists. Before the use of the Notes artifact, specialists gave help when solicited by their colleagues. With the use of the Notes artifact however, all specialists had access to the database of all calls being worked on by everyone in the department. As a result, they could browse through each others' calls to see which ones they could provide help on. Having information on all open calls in the department created an opportunity for specialists to improvise a new mode of giving help, proactively. Rather than waiting to be asked for help, specialists browsed the ITSS database and offered unsolicited help to each other via electronic mail or direct entries in the relevant call records. Specialists found this unanticipated change in collaboration practices very useful, for example:

> We all help each other out, you know. Like if I see Martha's gotten 15 calls and I've only gotten 3, I'm going to go in and I'm going to help her, whether she feels she needs it or not. I'm going to do some research for her. She does the same for me. And it's because, you know that one day you'll get killed, the next day you don't get killed. So, you're going to help whoever's getting hit the hardest that day.
>
> A lot of times I'll see something that's similar to what I may have already worked on. And I might be able to save them some time from even having to search by telling them what call I resolved this in. I'll send them Notes mail with my resolution.

The enactment of the technological improvisation pattern of use was influenced by the CSD institutional context. In particular, the cooperative culture in the department and the communal and open atmosphere fostered by the managers, generated a workplace in which exploring alternative ways of working and helping each other solve problems were valued aspects of the workplace. Specialists were encouraged rather than reprimanded for taking the initiative to overcome difficulties or develop new mechanisms for getting work done. While managers recommended a particular use of ITSS, they did not enforce it, being willing to accept workarounds and variations if these produced desired results. In a more hierarchic, competitive, and controlling environment the technological improvisation pattern of using the Notes artifact would be less likely.

Summary of Zeta's Technologies-in-Use

The two patterns of use enacted within Zeta both realized managerial intentions for the Notes artifact to support the tracking of incidents within the CSD, and to facilitate more effective management of CSD resources. Both can also be seen to fulfill the promise intended by Notes developers that their artifact would "facilitate collaboration." The institutional context of use played a significant role in facilitating such patterns of use, as did the motivations of the managers and specialists in utilizing a tool to help them deliver better service to their clients.

DISCUSSION

Applying the technology-in-use perspective to the studies of Alpha and Zeta reveals that a range of different technologies-in-use were enacted by social actors using the same technological artifact. These differences in patterns of use were realized across both the two organizations as well as within them. The consultants at Alpha were found to enact four different patterns of interaction with the Notes artifact, while the specialists at Zeta were seen to enact two different patterns of use with Notes. Identifying these different technologies-in-use and understanding how they are generated, why they differ, and how they are reinforced and changed offers the possibility of explaining why it is that technological artifacts are or are not associated with particular kinds of outcomes and organizational changes in different user communities, different contexts of use, and potentially different points in time. These variations in use may be associated with the different institutional contexts, motivations, and knowledge of relevant organizational actors.

As structures enacted in practice, technologies-in-use will, like other social structures, be strongly influenced by the institutional context of use. Such patterns of influence are evident in both Alpha and Zeta. The consultants within Alpha enacted technologies-in-use that barely or only occasionally utilized the powerful capabilities of the Notes groupware artifact. An examination of the rules and resources represented by the Alpha technologies-in-use reveals that the consultants drew on

established forms of knowledge, norms, and bases of power and legitimacy to guide their use (or nonuse) of the Notes artifact. Not surprisingly, such use largely reinforced the organizational status quo, and its hierarchical career path, individual criteria for evaluation and promotion, competitive hoarding of expertise, and time-based billing system. Where some of the technologies-in-use did provide some marginal and incremental improvements in communication and information transfer, none of these facilitated substantial changes in organizing structures or practices. Only one pattern of use, technological exploration, offered hints of the possibility that the technological artifact might be used to enact a new or different way of working. In their cautious experimentations, a few users explored new modes of distributing information, different norms for promoting competencies, and billing clients for value of services rendered rather than hours of time spent. While representing nascent rules and resources, these explorations were nevertheless stalled because the institutional context provided little support for innovative behavior and generated considerable disquiet about the risk and liability associated with untested and unofficial work procedures, norms, and policies.

The specialists in Zeta, on the other hand, appropriated the Notes artifact into their work practices so as to facilitate their customer support activities, while also improvising beyond the uses intended by management. An examination of the rules and resources represented by the Zeta technologies-in-use reveals that the specialists drew on both established and redefined forms of knowledge, norms, and bases of power to guide their use of the Notes artifact, thereby helping to change aspects of the organization. For example, informal norms around appropriate and "politically correct" process documentation emerged, as did indicators of reliable and quality knowledge for reuse. The structural shift to front and back lines introduced a hierarchical distinction into the department, and shifted the locus of power to senior consultants. Managers changed some of the evaluation criteria they used to assess specialists' performance, beginning to take account of Notes usage, extent of process documentation, and writing skills. Use of the Notes artifact by specialists both reinforced and changed the CSD status quo. It reinforced the CSD's team-based structure, collective orientation to problem solving, and cooperative behavior. It changed the CSD's largely undifferentiated team structure into one distinguishing junior and senior team members, and it centralized the knowledge of the department in a database accessible by all, facilitating information sharing and proactive help giving, as well as online monitoring by managers.

Another important contrast between the Alpha and Zeta uses of the Notes artifact was the relation of use to work practices. Within Zeta, the Notes artifact was specifically deployed to mediate the work of the CSD support specialists. This was the explicit objective behind the Notes adoption, the basis on which the ITSS application was designed within Notes, and the orientation during training

when specialists practiced on ITSS and Notes by working through simulated customer calls. At Zeta, thus, use of the Notes artifact was explicitly tied to work practices, and this relationship was expressly communicated to specialists in their mandatory and intensive training sessions. At Alpha, use of the Notes artifact was not tied specifically to the work practices of consulting. The motivation behind its adoption was a broad objective to improve information exchange and leverage the knowledge of the firm. The deployment of the artifact was left open ended, no work-specific applications were provided to users, and the training was brief, general, technical, and voluntary. Many consultants' had difficulty relating use of the artifact to their work practices and few of them saw much value in utilizing the artifact. It is thus not surprising that these consultants engaged in technological shunning, skepticism, and substitution. Where consultants did see some value, they explored use of the artifact in new ways but the continued lack of integration with work practices and unresolved issues of conflict with institutional norms prevented such efforts from having a sustained impact.

Applying the technology-in-use perspective to studies of technology, as I have done here, changes the research orientation from one that seeks universal outcomes from the use of a given technological artifact, to one that seeks generalizable patterns in the interactions users have with technological artifacts within specific technological and organizational conditions. Six patterns of using technological artifacts -- shunning, skepticism, substitution, exploration, facilitation, and improvisation -- were evident in the empirical studies of two different organizations and sets of users. More research is clearly needed, but these offer an initial and suggestive starting point. They suggest that in institutional contexts that resemble the Alpha Corporation (hierarchic, individualistic, competitive, time-oriented) and technological artifacts with features similar to those offered by the Notes product (collaborative, open-ended, customizable), actors will -- in the absence of task-specific applications and institutional support -- likely enact technologies-of-use that shun, substitute, or merely dabble with the artifact. In institutional contexts that resemble the Zeta Corporation's CSD department (team-based, cooperative, and problem-solving oriented) and technological artifacts with features similar to those offered by the Notes product (collaborative, open-ended, customizable), actors will -- in the presence of task-specific applications and support for use -- likely enact technologies-of-use that appropriate the artifact to facilitate and improve work practices. Such generalizations of the patterns found here to other settings and uses of artifacts is an important empirical question for future research.

The focus on technologies-in-use as distinct from the technological artifact also allows an examination of the extent to which users of the artifact realize the designers' intentions. It has long been recognized that artifacts are often not used as designed or intended (Bijker, 1995; von Hippel,

1988), but getting an adequate grasp of how, where, and why the slippage between design and use occurs in practice has been difficult. The analytic distinction I have proposed here between technological artifacts and technologies-in-use, offers I believe, a way to explore and explain this process. For example, the examination of the Notes artifact and its designers' intentions as well as the features built into the artifact, provides a profile of potential use that may be compared against the actual technologies-in-use realized in practice. It highlights the duality inherent in organizational technology, that technology entails both artifact and action. Of the six patterns of use discussed above, only the technological facilitation and improvisation technologies-in-use can be said to realize the collaborative intent of the Notes designers.

IMPLICATIONS

In this paper, I have argued that an understanding of technology requires a recognition of the relationship between the technologies we confront as artifacts in our daily lives, and the technologies-in-use we enact in our everyday practices. A distinction between technological artifact and technologies-in-use allows an investigation of how different technologies-in-use are structured by actors using a particular technological artifact over time. This framing is, I believe, a useful way of dealing conceptually with the puzzle that the prescribed technological artifact is not the same as the realized technology-in-use. To date, our conceptualizations of technology have tended to obscure this distinction. As Wynne (1988:148) puts it: "a formal public image of technology as mechanical, rule-following behavior belies a far less clearly rule-bound and determined world of real technological practices." Similarly, Barley (1990:99) argues for the importance of recognizing that "a technology's material constraints .... must be transformed into social forces." The notion of technology-in-use explicitly recognizes such a conversion; it represents the ongoing enactment through technology practices of the constraints and enablements afforded by technological artifacts.

Studying the action taken with technological artifacts within particular organizational contexts, does not relinquish the search for general patterns or regularities in relationships. To echo Suchman's (1987:179) point about human action in general, use of technological artifacts "is not predetermined, but neither is it random." The technology-in-use approach to studying technology in organizations explicitly requires the identification of patterns of situated interaction with an artifact. These patterns articulate how actors use (or don't use) specific technological artifacts within particular institutional contexts, and how these certain patterns of use generate rules and resources that structure organizational practices, either changing or reinforcing them. By conceiving of technologies-in-use as the patterned, situated interactions between artifact and action, we can identify, investigate, and compare different types of technologies-in-use realized with the same technological artifact. Without a notion of the kinds of action taken with technological

artifacts in particular contexts, organizational research cannot offer an account of why and how certain technological artifacts are associated with organizational stability and change.

To understand the complexity of technology-based organizational change, theoretical attention must focus not only on the technological artifact that enters into organizational processes, but also the technology that is constituted in practice. The vocabulary I have outlined here acknowledges and takes account of the ongoing dialectic between given technological artifacts and use of them in practice. This vocabulary allows us to capture important differences in what people do with technological artifacts in different places and at different points in time. Without distinguishing between technological artifact and technology-in-use, studies that measure technological deployment across organizations to predict the impacts of technology on organizations (structure, skills, work, performance, etc.) can only analyze technological artifacts ("prescribed technology") not the technology that is used in practice ("technologies-in-use"). This is because the configurations of hardware and software, methods, techniques, or knowledge that appear artifactually and conceptually on the factory floor or people's desktops, in workplace manuals or human cognitions, are different to the technology that is enacted in use by humans in the conduct of everyday activities. It has been estimated that US corporations spent upwards of $1 trillion on information technology in the last decade (BusinessWeek, 1993). What these corporations spent their money on was technological artifacts. Such artifacts will serve to facilitate human action when enacted as technologies-in-use. No statistics are available on the amounts and kinds of technologies-in-use being enacted in corporations because we have tended to focus on the material artifacts and downplayed their use in practice. The distinction between technological artifacts and technologies-in-use allows us to understand that investment in technological artifacts is no guarantee of corresponding organizational change around use of those artifacts. Organizational change depends not on technological artifacts alone but also, and more critically, on technologies-in-use.

With the conceptual vocabulary proposed here, analysts may begin to differentiate between adoption and implementation of technological artifacts and the uses to which they are put in organizations. It allows explanations of how and why use of technological artifacts may or may not conform to the intentions of the artifacts' designers, and how and why such use may result in anticipated and unanticipated changes in organizational structures, work practices, and performance. In addition, the perspective outlined here allows for comparative analysis across organizations by revealing similarities and differences in the technologies-in-use generated by use of the same technological artifact. The empirical example discussed above identified six different types of technologies-in-use that were being routinely enacted with a single technological artifact in

different contexts of use. While these findings are interesting in their own right, they also offer the possibility for investigating the generalizability of the technologies-in-use identified within Alpha and Zeta. Such an investigation might look at the use of the same artifact within the same organization over time, or at the use of different technological artifacts within the same organization. These technologies-in-use may also be examined across organizational contexts using the same technological artifact, as well as across organizational contexts using different artifacts. In addition, the focus on technologies-in-use recognizes that while they become reified such technologies-in-use can and do change and often initiate other structural changes in the process. In what conditions and with what intentions do actors change their habituated technologies-in-use are important empirical questions that can be addressed by the perspective proposed here.

The practice-based conceptualization of technology proposed here may be particularly useful given the kinds of technological artifacts being developed and implemented in organizations today. Sometimes referred to as "radically tailorable tools" (Malone. Lai, and Fry, 1992), these technological artifacts, typically realized in computer software, are less predetermined, fixed-function, and specific-purpose than prior artifacts. They tend to be more open-ended, serving as infrastructures or general-purpose platforms on which users may build their own local customizations and applications which convert the generic delivered artifact into a context-specific work aid. It is no longer possible with these technological artifacts to anticipate the kind of uses to which they will be put. When organizations acquired metal turning equipment, CT scanners, or ATM machines, the range of functions that could be invoked by users was largely given and constrained. While users could, and did, deviate from the prescribed functionality, appropriating the given artifacts to enact a variety of technologies-in-use, they were usually unable to modify the basic functionality of the artifacts. With the new information technologies being developed and deployed today, this is no longer the case, and users will have -- at least technically -- the capability of defining a wide array of functions with which to then enact various technologies-in-use. As Sproull and Goodman (1990: 257) note: "[P]rogrammable technology allows for the possibility of continuous redesign." Given such characteristics of artifacts, the ability to trace the kinds of organizational changes afforded by use of these new artifacts will require distinguishing between the artifact and the multiple situated uses actors enact with them.

Technology is a duality of action and artifact; if there is no action, there is no technology -- only artifact. While studying technological artifacts is a necessary condition for understanding technology in organizations, it is not sufficient to explain what humans actually do with those artifacts in particular organizational circumstances. And it is this latter that is the technological phenomenon of interest to organizational research.

REFERENCES

Barley, S.R. 1986. "Technology as an Occasion for Structuring: Evidence from Observation of CT Scanners and the Social Order of Radiology Departments," *Administrative Science Quarterly,* 31, 78-108.

Barley, S.R. 1988. "Technology, Power, and The Social Organization of Work," *Research in the Sociology of Organizations,* 6, 33-80.

Bijker, W.E. 1987. "The Social Construction of Bakelite: Toward a Theory of Invention," in W.E. Bijker, T.P. Hughes and T. Pinch, T. (Eds.), *The Social Construction of Technological Systems,* Cambridge MA: MIT Press, 159-187.

Bijker, W.E. 1995. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change,* Cambridge MA: MIT Press

Blau, P.M., Falbe, C.M., McKinley, W. and Tracy, P.K. 1976. "Technology and Organization in Manufacturing," *Administrative Science Quarterly,* 21, 20-40.

Burkhardt, M.E. and Brass, D.J. 1990. "Changing Patterns or Patterns of Change: The Effects of a Change in Technology on Social Network Power and Structure," *Administrative Science Quarterly,* 35, 104-127.

Cohen, I.J. 1989. *Structuration Theory: Anthony Giddens and the Constitution of Social Life,* New York, NY: St. Martin's Press.

DeJean, D. and DeJean, S.B. 1991. *Lotus Notes at Work.* Lotus Books, New York, NY.

DeSanctis, G. and Poole, M.S. 1994. "Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory," *Organization Science,* 5, 2, 121-147.

Giddens, A. 1979. *Central Problems in Social Theory: Action, Structure, and Contradiction in Social Analysis.* Berkeley, CA: University of California Press.

Giddens, A. 1981. "Agency, Institution, and Time-Space Analysis," in *Advances in Social Theory and Methodology,* 161-174, K. Knorr-Cetina and A.V. Cicourel (eds.), Boston, MA: Routledge & Kegan Paul.

Giddens, A. 1984. *The Constitution of Society: Outline of the Theory of Structure.* Berkeley, CA: U. of California Press.

Giddens, A. 1993. *New Rules of Sociological Method* (2nd ed.), Stanford, CA: Stanford University Press.

Kent, T. 1993. *Paralogic Rhetoric: A Theory of Communicative Interaction,* Cranbury, NJ: Associated University Presses.

Knights, D. and Willmott, H. (Eds.) 1988. *New Technology and the Labour Process,* London, UK: MacMillan Press.

Malone, T.W., Lai, K.Y. and Fry, C. 1992. Experiments with OVAL: A Radically Tailorable Tool for Cooperative Work, *Proceedings of the Conference on Computer Supported Cooperative Work,* Toronto, Canada: ACM/SIGCHI & SIGOIS, 289-297.

Marx, L. and Smith, M.R. 1994. (Eds.) *Does Technology Drive History?* Cambridge, MA: MIT Press.

Noble, D. 1984. *Forces of Production: A Social History of Industrial Automation,* New York, NY: Knopf.

Orlikowski, W.J. 1991. "Integrated Information Environment or Matrix of Control?: The Contradictory Implications of Information Technology," *Accounting, Management, and Information Technologies,* 1, 1: 9-42.

Orlikowski, W.J. 1992a. "The Duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science*, 3, 3, 398-427.

Orlikowski, W.J. 1992b. "Learning from Notes: Organizational Issues in Groupware Implementation," *Proceedings of the Conference on Computer Supported Cooperative Work,* Toronto, 362-369.

Orlikowski, W.J. and Gash, D.C. 1994. "Technological Frames: Making Sense of Information Technology in Organizations," *ACM Transactions on Information Systems,* 12, 2: 174-207.

Orlikowski, W.J., Yates, J., Okamura, K. and Fujimoto, M. 1995. "Shaping Electronic Communication: The Metastructuring of Technology in Use," *Organization Science,* 6, 4: 423-444.

Perrow, C. 1983. "The Organizational Context of Human Factors Engineering," *Administrative Science Quarterly,* 28: 521-541.

Pinch, T.J. and Bijker, W.E. 1984. "The Social Construction of Facts and Artefacts: or How the Sociology of Science and the Sociology of Technology might benefit each other," *Social Studies of Science,* 14, 399-441.

Powell, W.W. 1987. Explaining Technological Change, *American Journal of Sociology,* 93, 1: 185-197.

Scott, W.R. 1990. "Technology and Structure: An Organizational Level Perspective, in P.S. Goodman, L.S. Sproull, and Associates, *Technology and Organizations,* San Francisco, CA: Jossey-Bass, 109-143.

Sewell, William H. Jr. 1992. "A Theory of Structure: Duality, Agency, and Transformation," *American Journal of Sociology,* 98, 1, 1-29.

Sproull, L.S. and Goodman, P.S. 1990. "Technology and Organizations: Integration and Opportunities," in P.S. Goodman, L.S. Sproull, and Associates, *Technology and Organizations,* San Francisco, CA: Jossey-Bass, 254-265.

Suchman, L.A. 1987. *Plans and Situated Actions: The Problem of Human Machine Communication,* Cambridge, UK: University of Cambridge Press.

Taylor, C. 1993. "To Follow a Rule ..." in *Bourdieu: Critical Perspectives,* 45-60, C. Calhoun, E. LiPuma, and M. Postone (eds.), Chicago, IL: University of Chicago Press.

Trist, E.L., Higgin, G.W., Murray, H. and Pollock, A.B. 1963. *Organizational Choice,* London UK: Tavistock.

Turkle, S. 1984. *The Second Self: Computers and the Human Spirit* New York: Simon & Schuster.

Tyre, M.J. and Orlikowski, W.J. 1994. "Windows of Opportunity: Temporal Patterns of Technological Adaptation in Organizations," *Organization Science,* 5, 1, 98-118.

von Hippel, E. 1988. *The Sources of Innovation,* New York, NY: Oxford University Press.

Weick, K. 1979. *The Social Psychology of Organizing,* Reading MA: Addison-Wesley.

Weick, K. 1990. "Technology as Equivoque," in P.S. Goodman, L.S. Sproull, and Associates, *Technology and Organizations,* San Francisco, CA: Jossey-Bass, 1-44.

Whittington, Richard. 1992. "Putting Giddens into Action: Social Systems and Managerial Agency," *Journal of Management Studies,* 29, 6, 693-712.

Winner, L. 1986. *The Whale and the Reactor: A Search for Limits in an Age of High Technology,* Chicago, IL: University of Chicago Press.

Wynne, B. 1988. Unruly Technology: Practical Rules, Impractical Discourses and Public Understanding, *Social Studies of Science,* 18, 147-167.

Yates, J. 1993. "Co-Evolution of Information Processing Technology and Use: Interaction between the Life Insurance and Tabulating Industries," *Business History Review,* 67: 1-51.

Yates, J. and Orlikowski, W.J. 1992. "Genres of Organizational Communication: A Structurational Approach to Studying Communication and Media," *Academy of Management Review,* 17, 2, 299-326.

Zuboff, S. 1988. *In the Age of the Smart Machine*, New York: Basic Books.

Zucker, L.G. 1977. "The Role of Institutionalization in Cultural Persistence," *American Sociological Review,* 42, 726-743.

FEATURE	POTENTIAL FUNCTION
Electronic Communication	Electronic messaging to geographically dispersed community via email Announcements and responses on widely distributed electronic bulletin boards Importing of newsfeeds from external services Electronic mail gateways to transfer Notes email messages to other systems
Text Editing	Creation and editing of documents that include multiple field types and formats with an emphasis on free-form textual information Importing of text, tables, spreadsheets, graphics, images, and sound from other programs
Document Management	Creation and management of databases of documents in a variety of views Search and retrieval of individual or groups of documents based on indexes or free text searches
Customization	Direct manipulation of user interface Modification of default views and database templates
Integration	Connection between various features -- communication, text editing, and document management
Replication	Periodic, scheduled duplication of designated databases across Notes servers in a wide-area network Support for stand-alone computers through dial-up into a Notes server
Security	Provision of password protection and ID verification to control access to databases Support for data encryption at level of email messages, databases, documents, and particular fields
Application Development	Programming of unique database applications via Notes Application Programming Interface Computation of totals, averages, and other statistics on any field

Table 1: Key Features of the *Notes* Technological Artifact (from DeJean and DeJean, 1991)

Technologies-in-Use Practices	*Technological Shunning*	*Technological Skepticism*	*Technological Substitution*	*Technological Exploration*
Primary Actors	Consultants at all levels	Principals and Managers	Managers, Senior Consultants, and Administrators	Principals, Managers, and Senior Consultants
Action with respect to Technological Artifact	No use of Notes	Sporadic and less than enthusiastic use of Notes	Regular use of Notes for existing forms of communication and information transfer	Periodic use of Notes to experiment with new ways of sharing information
Motivation, Intention for Action	Deliver timely and quality service to clients Develop individual expertise Maintain/build client relations	Deliver timely and quality service to clients Develop individual expertise Maintain/build client relations	Deliver timely and quality service to clients Develop individual expertise Maintain client relations	Deliver timely and quality service to clients Promote personal expertise Maintain/build client relations
Institutional Context	Partnership with matrix operating structure "Up or out" career path Time-based billing procedures Deadline-oriented engagements Individual work assignments Evaluation criteria directed at individual performance and distinctive competence Existing policies on data quality and confidentiality, not extended to electronic media	Partnership with matrix operating structure "Up or out" career path Time-based billing procedures Deadline-oriented engagements Individual work assignments Evaluation criteria directed at individual performance and distinctive competence Existing policies on data quality and confidentiality, not extended to electronic media	Partnership with matrix operating structure "Up or out" career path Time-based billing procedures Deadline-oriented engagements Individual work assignments Evaluation criteria directed at individual performance and distinctive competence Existing policies on data quality and confidentiality, not extended to electronic media	Partnership with matrix operating structure "Up or out" career path Time-based billing procedures Deadline-oriented engagements Individual work assignments Evaluation criteria directed at individual performance and distinctive competence Existing policies on data quality and confidentiality, not extended to electronic media
Knowledge of Technological Artifact	Limited technical knowledge Limited understanding of utility of Notes for consulting practices	Limited technical knowledge Little understanding of utility of Notes for consulting practices	Some technical knowledge Specific understanding of the utility of Notes to automate existing consulting procedures	Moderate technical knowledge Some understanding of the potential of Notes to improve work practices
Capabilities of Artifact Appropriated	None	Electronic mail	Electronic mail Newsfeeds Text editing	Electronic mail Text editing Electronic discussions Customization
Implications for Organization Change	Reinforcement of existing consulting work practices	Reinforcement of existing consulting practices with marginal changes in mode of communication	Reproduction of consulting practices with incremental change in communication and information transfer	Reproduction of work practices but with some signs of potentially innovative change

Table 2: Technologies-in-Use enacted with the *Notes* artifact within Alpha (1991)

Technologies-in-Use Practices	*Technological Facilitation*	*Technological Improvisation*
Primary Actors	All support specialists	Many support specialists
Action with respect to Technological Artifact	Extensive use of Notes and the ITSS application to enter calls, search prior solutions, document work process, transfer calls, and communicate	Use of Notes and the ITSS application to enter calls later, censor docuementation, provide unsolicited help, engage in ad hoc learning, and train novices
Motivation, Intention for Action	Deliver timely and accurate technical support to customers Keep track of customer calls Support work of specialists	Deliver timely and accurate technical support to customers Keep track of customer calls Support work of specialists
Institutional Context	Team-based structure Limited hierarchy Cooperative culture Shared call responsibility Evaluation criteria include individual problem-solving ability and "being a team player"	Team-based structure Limited hierarchy Cooperative culture Shared call responsibility Evaluation criteria include individual problem-solving ability and "being a team player"
Knowledge of Technological Artifact	Moderate technical knowledge Detailed understanding of utility of Notes (via ITSS) for technical support practice	Moderate technical knowledge Some understanding of utility of Notes (via ITSS) to facilitate adaptation of support practices
Capabilities of Artifact Appropriated	Text entry and edit Searching the database Document management Electronic mail	Text entry and edit Searching the database Electronic mail Electronic perusal
Implications for Organization Change	Change in work practices and norms, distribution of work, and coordination mechanisms	Change in work practices and norms, collaboration, and learning mechanisms

Table 3: Technologies-in-Use enacted with the *Notes* artifact within Zeta (1992-1994)

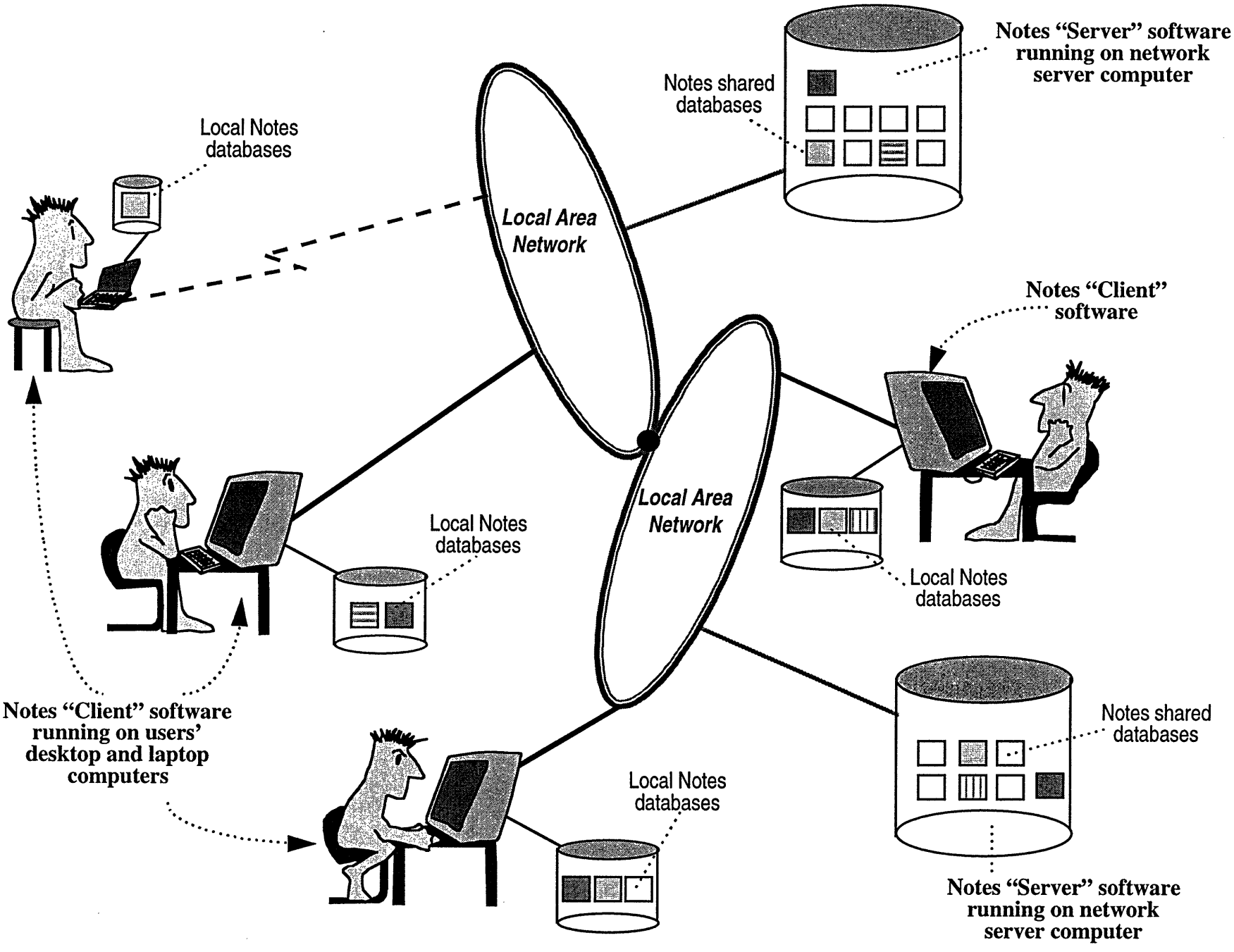

Figure 1: Technical Infrastructure of Lotus *Notes* Technological Artifact

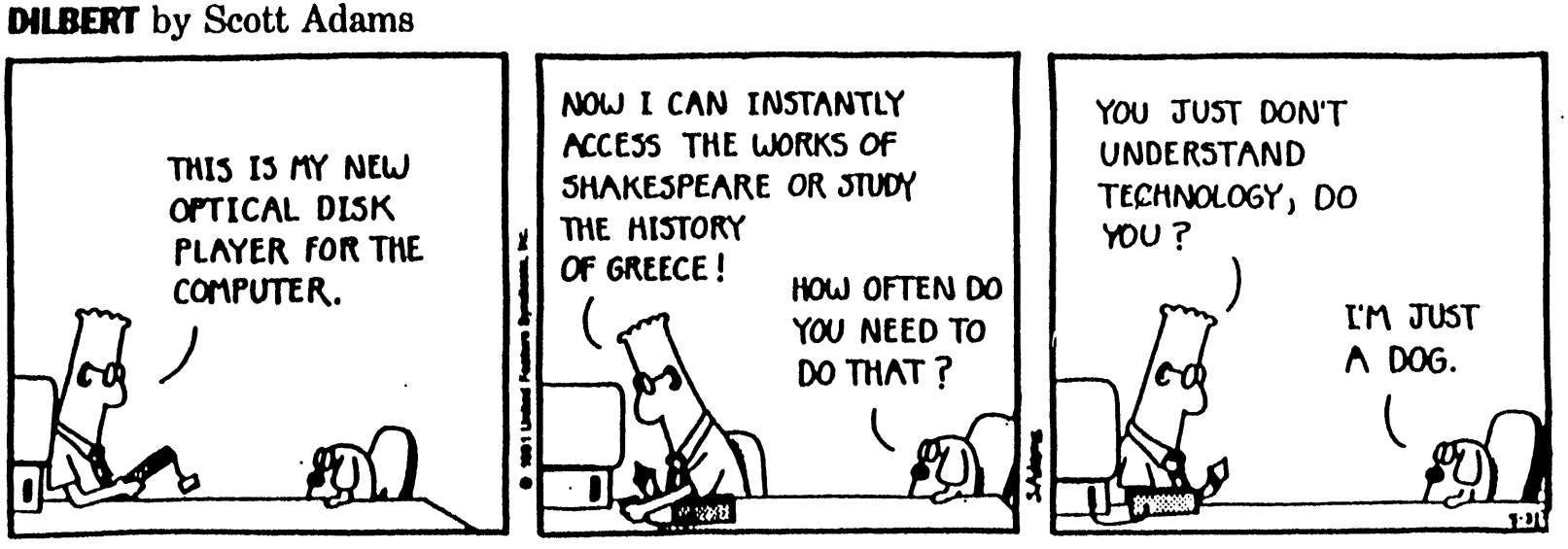

Figure 2: Example of *Technological Skepticism*