Computer-Mediated Work

Individual and Organizational Impact in One Corporate Headquarters

Tora K. Bikson, Cathleen Stasz, Donald A. Mankin
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PREFACE

This report describes how computer-based information technology was introduced into one white-collar work setting, and explores the consequences to employees and the organization. The research extends prior work on information systems in varied user contexts and illustrates factors that underlie successful technological innovation in organizations.

The project reported here relies on two lines of previous Rand research: studies of technology transfer and utilization, and studies of organizational innovation. These lines of inquiry converge on the question of how technical advances can most successfully be translated into applied benefits. Recent Rand research on advanced information tools in office settings suggests the importance of implementation process characteristics for successful organizational innovation. That research provides the immediate context for this case study.

The study was supported by Contract No. 433-0045-0 from the Congressional Office of Technology Assessment (OTA). It is one of four case studies funded by OTA to help evaluate the actual and potential impacts of new information and communication technologies in the workplace. OTA's investigation of these workforce issues was stimulated by requests from the Senate Labor and Human Relations Committee and the House Education and Labor Committee.

An earlier draft of this report was incorporated into OTA's 1985 report to Congress: The Automation of American Offices.
SUMMARY

By the end of this decade, 50 million U.S. office employees may be doing computer-mediated work. The rapid diffusion of information tools is driven both by organizational demand and technology supply. On the one hand, technical advances have increased processing power per unit of cost so greatly that even many small organizations are planning for or acquiring office computer systems. On the other hand, the need for information tools has become more pressing. The costs of information-related work in organizations have steadily increased while growth rates for white-collar productivity have decreased.

The question is whether advancing information technology will enable organizations to operate more effectively in today's information-intensive environments. The answer largely depends on how the problems are conceptualized and how proposed solutions are developed. Firms currently do not have well-founded strategies for implementing advanced information systems and do not know how to project and assess their consequences, including impacts on individual workers and work groups as well as on the performance of the whole organization. In the past, the implementation of computer-based information technology has been described as "office automation," a term that assumes the innovative technology will do nothing more than mechanize extant information tasks—and probably alienate information workers in the process.

This report comprehensively examines the organizational and individual impacts of implementing advanced information technology in one corporate headquarters. Several years ago, "Company XYZ" made a substantial commitment to implementing advanced information tools. From XYZ's perspective, the implementation process has been a success story. Since the introduction of the innovative tools, the company has cut total costs per unit output and has moved from fourth to second position among its competitors. Moreover, most of its employees agree that the new tools have enriched their work and increased its speed and quality.

XYZ's innovation effort appears to have succeeded for a complex of reasons. A conceptual framework developed in previous research suggests that success is explainable in terms of three components: characteristics of the organization, its information technology, and its implementation program.

XYZ proved to be highly receptive to the implementation of advanced information technology. Under the direction of its Chief
Executive Officer, it espouses and practices a policy of “growth through information, experimentation, and communication.” It hires high-quality employees, encourages them to exercise initiative, and rewards them well for high performance.

XYZ implemented an advanced information system—really a web of systems—that is mission-focused, user-driven, and designed for change. The system comprises varied hardware, operating systems, databases, and software applications adapted to the varied needs of its users. The system can be modified even by users who lack technical expertise, and is designed to evolve as users’ needs change and as new technologies appear.

Unlike some firms, XYZ carefully planned its implementation strategy and committed substantial resources to it—almost half of the total information system’s expense. From the very beginning, it developed the system with input not only from top management and experts but also from users and user departments, with the result that its employees feel the system is “theirs.” The firm recognizes that organizational innovation necessarily entails experimentation, risk-taking, and occasional failures—but regards failures as truly negative only if the organization does not learn from its mistakes. XYZ also understands that implementing advanced information tools must be an open-ended process. Thus the firm is learning to manage change rather than minimize it.

XYZ’s experience holds an important lesson for other organizations: The implementation of innovative information technologies can yield both economic performance payoffs and human resources benefits.
ACKNOWLEDGMENTS

We are indebted to our colleagues in several departments at The Rand Corporation (Behavioral Sciences, Information Sciences, System Sciences) for their suggestions and comments throughout this research project. We have also benefited greatly from formal reviews by Dr. Louis Miller (Chairman, Rand's Information Sciences Department), Dr. Robert Yin (Principal, Cosmos Corporation), Office of Technology Assessment research staff directing the study of Communication and Information Technologies in the Office, and representatives of the organization described in this report. Special thanks go to Dr. Rick Eden (Communications Analyst), who improved the structure of this report and drafted the summary.

Most of all, we wish to thank members of the participating organization who cooperated in countless ways with the research project. We adopted their philosophy of open communication, and learned a great deal from the experience.
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I. INTRODUCTION

Information work is becoming an increasingly larger yet decreasingly productive component of the economy. Costs for information work have steadily increased: White-collar employees now constitute over half the U.S. labor force and account for $1 trillion, or roughly 70 percent of industry’s annual payroll (American Productivity Center, 1982). However, growth rates for white-collar productivity have decreased (Congressional Budget Office, 1981).

In an effort both to reduce the costs and increase the productivity of information work, many firms are implementing advanced information technology, often on a large scale. Moreover, the demand pull has been complemented by a technology push. Technical advances (e.g., integrated circuits, fourth-generation languages) have so increased processing power per unit of cost that even many small organizations are planning for or acquiring office computer systems (e.g., Walton, 1982). By one estimate, 50 million U.S. office employees will be doing computer-mediated work by 1990 (International Data Corporation, 1981).

Whether advancing information technology will enable organizations to operate more effectively in today’s information-intensive environments depends largely on how the problems are conceptualized and how proposed solutions are developed. Little is known about the implementation process: Although firms hope, of course, that their often substantial investments in computer-based tools will pay off in performance gains, in truth they do not have well-founded strategies for implementing advanced information systems or for projecting and assessing their consequences, including impacts on individual workers and work groups as well as on the whole organization. In fact, some observers have construed the implementation of advanced information systems as “office automation,” a term that assumes the innovative technology will do nothing more than mechanize extant information tasks—and probably alienate information workers in the process. Uncertainty about impacts is exacerbated by the dramatic technological change expected to characterize information tools for the remainder of the century (Drucker, 1981). The fact of quick and constant change means that a firm’s decision to implement state-of-the-art technology will become a long-term commitment to the implementation process.

The study described in this report provides a comprehensive understanding of the organizational and individual impacts of implementing
advanced information technology in one corporate setting, which we will refer to as Company XYZ. Specific objectives of the research are to:

- Provide a picture rich enough to illustrate the kinds of events that computer system implementation may involve, and creative approaches to coping with them.
- Use this picture to illustrate a conceptual framework that, we believe, well describes organizational innovation processes.
- Explore characteristics from this effort at organizational change that are related to its apparently successful outcomes.

Our interviews with employees at XYZ revealed virtual consensus on several points:

- Most users interviewed felt that the new information tools increased their access to information, their ability to manipulate it, and their flexibility in performing tasks.
- Most believed the tools had improved productivity on every level—individual, departmental, and organizational.
- Most reported increased job satisfaction.
- Most reported either "task reinvention"—finding unanticipated uses for the technology or helping others use it—or "tool reinvention"—innovatively adapting the technology itself or generating new applications.
- Most said that the new tools had not changed management style or resulted in formal job changes.

On other items, responses were more variable. For example, even though almost all interviewees reported time savings with the new information system, not everyone reported a decrease in total work demand. Changes in that demand apparently depended on the goals and functions of the work group, the design of the job, and the initiative and motivation of the individual user.

Our own observations corroborated the interviewees’ impression that the implementation effort had been largely successful. Moreover, XYZ’s profit-and-loss performance and market-share gains substantiate claims that its productivity has improved. XYZ has cut total costs per unit output and has moved from fourth to second position among its competitors.

Applying the conceptual framework presented in Sec. II, we identified several features of XYZ, its information technology, and its implementation program that may explain its success.
XYZ was and is receptive to technological advance. It espouses a policy of "information, experimentation, and communication" and genuinely acts in accordance with it. It encourages independence and initiative, selects highly competent employees, and rewards performance.

The computer technology installed at XYZ possesses three potentially generalizable characteristics. First, it is mission-focused—it is adapted to the needs of its users. As a result, it incorporates varied hardware, operating systems, databases, and software applications. Second, the system is user-driven; it can be modified and manipulated by end users who lack technical computer expertise. Third, the system is designed to accommodate change; it will evolve with its users' needs and expertise and with new technologies as they emerge.

The conceptual framework suggests that six features of the implementation strategy at XYZ contributed to its success:

- The organization had a conscious implementation strategy and devoted sufficient resources to it (40 percent of the total information system's expense).
- XYZ has accepted experimentation and risk-taking as necessary elements in organizational innovation.
- XYZ developed—and continues to develop—the information system with input from top management, technical experts, and users.
- The users and user departments participate in decisions associated with the system, with the result that the employees feel they "own" it.
- The implementation process includes an adaptive, eclectic training program that complements initial formal training sessions with ongoing informal skill diffusion.
- XYZ recognizes that the implementation of advanced information technology is an open-ended process. Rather than attempting to minimize change, the firm is learning to manage it.

This single-site study suggests that information technology, contrary to a commonly expressed fear, need not entail negative consequences for the white-collar worker. Instead, advanced computer-based tools can increase the speed and improve the quality of information work while also enriching that work for the worker.

Succeeding sections of this report describe the research approach (Sec. II), the organization (Sec. III), the implementation process (Sec. IV), the technology currently in use (Sec. V), and its impact on users
and user departments (Sec. VI). The information in Secs. IV and V, plus the first part of Sec. VI, draws exclusively on interview data. Section III also makes use of organization charts and other internal documents describing the firm. While these descriptions combine and paraphrase material from multiple sources, we have tried to stay as close as possible to the language of the respondents and to provide representative quotations. However, to protect proprietary data and respondents’ identities, we have used a fictitious firm name and have obscured other information about the firm’s structure and operations. The concluding subsections of Sec. VI fit these descriptions to the conceptual model of technological innovation outlined above and discuss their implications. Appendix A contains three samples of interview protocols. Appendix B addresses thirteen issue areas associated with the implementation of advanced information technology. Appendix C offers four vignettes illustrating the application of advanced information technology to information work at XYZ.
II. RESEARCH APPROACH

CONCEPTUAL FRAMEWORK

Much recent research has dealt with innovative technologies in applied contexts (Tornatzky et al., 1983). Across varied subject matters and settings, highly congruent results have emerged. We therefore drew on this body of literature to develop a conceptual framework for studying computer systems in white-collar work (Bikson, Gutek, and Mankin, 1981).

The consensus from research in this field (e.g., Tornatzky et al., 1983; Johnson et al., 1983; Eveland and Rogers, 1980; Bikson, 1980; Berman and McLaughlin, 1978; Yin et al., 1976) is that technological innovation in organizations must be understood as a function of three interrelated components: the innovative technology, the context into which it will be introduced, and the process of embedding the technology in the context (the implementation process). Of the three components, implementation is the chief determinant of success or failure.

These conclusions, corroborated by our own large-scale investigation of computers in private sector office settings, guided the design of this case study (Bikson, Gutek, and Mankin, 1985; Mankin, Bikson, and Gutek, 1985; Gutek, Bikson and Mankin, 1984).

RESEARCH DESIGN

For purposes of this research we defined a "case" as a geographically and operationally distinct organizational whole. By this definition, for example, the University of California and Xerox Corporation would not constitute "cases" but UCLA and Xerox North American Manufacturing Division would. The case we selected for study is the national headquarters for a medium-sized consumer product manufacturing firm. Its employees carry out all corporation-wide planning; in addition, they supply products to half the United States. Thus it is a "working" headquarters, carrying out both staff and line functions. The case, so construed, bounds the study we conducted and serves as the broadest organizational unit of analysis.

The organization, in turn, is viewed as the embedding context for work groups, or identifiable subsystems of organizations that have recognized purposes which unify their employees and activities (Trist, 1981). Any line department of an organization qualifies as a work
group. However, this case study includes only white-collar work groups, or organizational subunits for which information generation, transformation, or transmission are central activities (Bikson and Gutik, 1983). Four such groups were targeted, with different but related functions.

Work groups, finally, provide the behavior settings for individual employees (Talbert, Bikson, and Shapiro, 1984), who make up the smallest unit of analysis. Within each department, five employees representing varied occupational strata took part in the study. (See Figs. 1 to 5 in Sec. III for details.)

Level-of-analysis issues in organizational research have been well examined elsewhere and will not be discussed here (see, for example, Katz, Kahn, and Adams, 1980). An organization is a complex whole that requires study at multiple levels; in particular, for our present purpose, the intermediate departmental level is important for understanding how white-collar technology affects work and workers:

- This level accords more closely with what is meant by an "office" both in organizational research and in "office of the future" literature (Bikson, Gutik, and Mankin, 1981);
- Computer system applications are typically selected and implemented for subunits of organizations (Ellis and Nutt, 1980), since tasks and functions differ substantially between departments;
- Within any sizable organization there is dramatic variation both in nature and extent of diffusion of innovative technologies among work groups (Bikson, Gutik, and Mankin, 1981).

The context of innovation, then, comprises three levels: the organization, its work groups, and the individuals who staff them.

The new technology of interest is the computer system deployed to support a multiplicity of white-collar tasks. Its introduction affords a common and visible event for delimiting this exploration. Specifically, questions about the impact of information technology have been temporally defined to refer to work changes and employee effects that have occurred since the first use of multifunction interactive computers by employees within work groups selected for study (Bikson, Gutik, and Mankin, 1981; Yin et al., 1976). The departments in this study began to work on-line during 1980.

Although we view properties of computer technology and the context of its use as important, we have concentrated on implementation in this research. We began by assuming that the introduction of computers into white-collar work is an adaptation process (Talbert, Bikson,
and Shapiro, 1984) involving social units at the three levels of aggregation described above. We define it as the sequence of activities—moving from symbolic (e.g., planning), to behavioral (e.g., training), and from early trials to changed work repertoires—that takes place between an organization's decision to acquire new technology and the technology's incorporation into regular operating procedures (Tornatzky et al., 1983). Our aim was to learn about this process in one corporate headquarters: how it began and evolved; who were the key actors and the roles they played; in what ways information technology is used; and what the consequences have been.

RESEARCH METHOD

So viewed, this research focuses on the implementation of computer-based procedures in white-collar contexts. Case study is a useful method for delineating and interpreting a contemporary process in a real-world context—especially when the boundaries between the process and the context are not sharp and when the variables of interest far outnumber the possible data points (see, e.g., Yin, 1981).

The method we employed draws its general features from the implementation case-study approach developed and elaborated in Rand's program of research on organizational innovation by Pincus, Berman, McLaughlin, Yin and others during the past ten years. Semistructured interviews constitute the primary data-gathering procedure, supplemented by researchers' informal observations and archival information about the firm as a whole.

Selection of Respondents

Interview data were collected to represent the three levels of the research design, with numbers of respondents distributed as follows:

Organization
- Executive management (2)
- Personnel department (1)
- Technical department (2)
- Key actors, that is, other people who played key roles at the organization level in the implementation process (2)

Work Group
- Department Heads (4)
- Linking actors, that is, individuals outside the focal work groups identified as links in the intra-organizational diffusion process (8)

Individual: employees of focal departments (20)
We have explained why we chose this study site: It provides an example of the successful introduction of information technology in a traditional industry whose employees were not initially experienced in the use of computer systems. At the organization level of XYZ we interviewed people who represented general executive decisionmaking as well as personnel and technology policy. We also interviewed organization-level actors who exercised a strong de facto influence on implementation processes even though it was not an area of their formal responsibility.

At the work group level, we chose four departments with different but related functions: They handle product development (an R&D activity), production and operations planning, market research, and fiscal control (see Sec. III). We selected them to strengthen the potential transfer of findings: Most manufacturing firms have such departments, and service sector firms are likely to have one or more similar offices (a comptroller's office, and perhaps offices that carry out market research or operations planning). While participating groups include support-level employees, we chose not to study any departments whose primary work is clerical (e.g., word processing) or technical (e.g., data processing); these groups are already overrepresented in research on the effects of information technology. At the work group level, we interviewed each department manager. We also interviewed “linking actors,” employees outside those departments whose work began either to affect or be affected by focal group activities as a consequence of the new technology.

Within each department, five employees were recruited to represent individual-level impacts. For this purpose we attempted to span the departmental hierarchies, including a diversity of job levels as well as job functions. As Fige. 2 to 5 indicate, we succeeded in obtaining a heterogeneity of respondents.

In sum, respondents were selected whenever possible on the basis of their formal position in the organization chart (e.g., department heads). Others (e.g., key actors, linking actors) were identified during the data-collection process. Interviewees were strongly interested in the research issues, and we encountered no refusals.

Construction of Protocols

Semistructured interview protocols were administered to all respondents and required one to two hours to complete. The protocols were developed from a list of items about which we sought information, including initial reasons for conversion to computerized procedures,
how users were trained, subsequent changes in the nature of work, and effects on organizational performance.

Questions in this item pool were then assigned to appropriate levels (organizational, departmental, individual) and role incumbents (e.g., executive management, linking actor, user). After all were assigned, we organized them into interview protocols, with each item repeated in at least two. On that basis we generated six distinct but overlapping interview protocols (Appendix A includes a sample interview protocol from each of the three levels studied). Each focal department was assigned to one researcher for data-gathering; other participants were divided among the three researchers.

Data Analysis and Interpretation

Field notes taken during research visits were used to construct case reports for each department and for organizational actors; these then became the evidentiary base for subsequent examination. The interview protocols themselves served to structure analysis and interpretation, since responses to identical items could be compared across groups and levels in the research design.

Preliminary research findings developed in this manner were then reported to the participants in feedback seminars. These sessions served to confirm descriptive information, validate conclusions, and generate clarifying discussion around issues this organization faces as the technological innovation process continues.
III. ORGANIZATION OVERVIEW

This section describes the context into which the computer-based procedures were introduced, from three perspectives. The first presents the site in terms of readily identifiable and quantifiable characteristics. These “physical” dimensions include product, size, location, formal structure, job categories, and demographic properties. The second presents the organization’s philosophy and goals as expressed in company manuals, publicity materials, and handbooks. The third summarizes actual written policies.

PHYSICAL CHARACTERISTICS

The research site is the national corporate headquarters for Company XYZ, a major manufacturer of consumer products. The company also has four manufacturing plants, one of them physically adjacent to and directly managed by the headquarters office, and the other three located elsewhere around the country. There are almost 300 employees in the corporate headquarters and approximately 1000 employees overall. The company is a wholly-owned subsidiary of a larger corporation.

The study focused on four departments within the research site:

- The Marketing Research Department provides information to aid long- and short-term decisions regarding efficient and effective operation of the company in the marketplace. It compiles and analyzes information about the public and the competition. Organizationally, this department reports to the Information Services Director and to the V. P. for Service and Finance.
- The Planning Department administers the planning process and manages XYZ's overall logistics function. The Business planning group is strategic in nature; it coordinates the whole planning process. The Operations planning group is more tactical; it forecasts sales, production, and raw material needs. The Business and Operations planning managers report to the Planning Director, who reports to the V. P. for Service and Finance.
- The formal mission of the Controller's Office is “to provide timely, accurate, responsive and high-quality service to support the goals of the business through the protection of company assets and in compliance with General Accounting Procedures.”
The functions of the National Accounting Office, the particular unit within the Controller's Office in which most of our respondents are based, are financial reporting and internal control. This involves paying vendors and suppliers, tracking customer accounts and applying customer payments to these accounts, inventory control, cost budgeting for other departments, and financial analysis.

- The Product Development Department develops and maintains current products. It provides formulas for what is to be produced each quarter, making use of information about raw materials, existing inventories, customer orders, and the desired characteristics of products. On the basis of formulas so generated, it places orders for raw materials to supplement existing supplies, and sends production plans to the plant. Both types of information are also forwarded to the planning department.

A simplified organization-level chart (Fig. 1) shows the location of each focal department within the company, and identifies the organization-level key actors who were interviewed. Roman numerals in the margin of Fig. 1 (and all subsequent organization charts) indicate the hierarchical levels defined by the larger corporation of which XYZ is a subsidiary. The President of the overarching corporation is at level I, the subsidiary presidents at level II, vice presidents at level III, and so on, down to level VII. Nonexempt hourly employees are located below level VII on subsequent charts. Although Technical Resource Consultants (TRC) is not a part of XYZ, we have included them on the chart because of their close functional relationship to the firm. TRC has an on-site office and two of its employees were interviewees for this study.

Group-level charts for each focal group are presented in Figs. 2 through 5, with all interviewees (managers and employees) indicated by asterisks. Since the formal boundary of the Controller's office includes several off-site employees (located in manufacturing plants) who only interact occasionally with the headquarters staff, they were excluded from our definition of the focal group. The one exception is the Service and Finance Manager in the on-site plant (Plant A) who does have close contact with other employees in headquarters. Similarly, we defined the Product Development group to include only New Products and Core Business because of their high degree of functional interdependence. The boundaries for both of these groups as we defined them are indicated in their respective figures. Linking actors, who could report on changes in local groups and communication lines from a perspective external to the focal groups, are also indicated.
Table 1 summarizes demographic characteristics of the four focal groups as estimated by their managers, and of the company as a whole as estimated by the Director of Administration and Personnel.

A number of other features characterize this research site: little union involvement (only one of the four plants is unionized); high pay (in the upper quartile of comparable companies); and a high degree of career mobility. According to the Director of Personnel, all patterns of mobility occur—throughout the organization upward and laterally, within and outside the company, without one particular pattern predominating. This absence of a general pattern holds true for all focal groups except Planning. Employees in this group tend to move up to other departments in the hierarchy and remain within the company. Consequently, in contrast to other departments, none of the Planning Department members during system implementation in 1980 were still in that department at the time of this study.

COMPANY PHILOSOPHY

XYZ's policies and beliefs are important to an understanding of how computers have affected it. Presented below are several quotations from publications that give the company's views.

The first set of excerpts have to do with the company's expressed beliefs about the importance of treating employees well and giving them the freedom, opportunity, and rewards to perform effectively:

"I feel like a real part of the XYZ team. And that sense of teamwork goes beyond just where we work. We all know that our business will grow and prosper only if it benefits everyone affected by it."

"Working together has a special meaning at XYZ. We are striving to recognize and respect every individual's abilities, talents, and contributions."

"I enjoy being with XYZ. I don't feel I'm a faceless entity in a big company. XYZ is an equal opportunity employer in the true sense. Opportunities are as tangible as they are equal."

"XYZ seeks to attract, motivate, and retain above average employees with a total compensation program which recognizes responsibility, rewards performance, shares prosperity, and provides long-term security in the benefit program."
Table 1

COMPARATIVE DEMOGRAPHICS IN FOUR FOCAL DEPARTMENTS

<table>
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<th></th>
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<th></th>
<th>Controller's Office</th>
<th></th>
<th>Product Development</th>
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<th>Company XYZ Overall</th>
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<td>B.A.</td>
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<td>3 Ph.D.s</td>
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<td>3 Ph.D.s</td>
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</table>

15
Fig. 1—Simplified organization level chart, company XYZ
Fig. 2—Group-level organizational chart, Marketing Research

KEY
* interviewees
NOTE: Linking actors interviewees were in Sales Planning under Sales and Distribution.
Fig. 4—Group-level organizational chart, Controller's Office
“At XYZ we are developing an innovative style of organization. It’s a concept that seeks to give employees greater satisfaction in their role by allowing them a good deal of self-management and a working environment they can influence. The result of this freedom is a collective commitment and involvement in the business.”

A second theme is the importance of open communications:

“Our goal is to have ideas, information, and opinions flow freely so that there is a sharing of trust and understanding. We’re constantly encouraged to express our views with any other member of the Company.”

“At XYZ our working environment is open. There are no private offices. Free communication is encouraged. This produces a climate and style highly conducive to productivity.”

Viewing the internal functioning of the organization from a systems perspective is a third theme:

“We view productivity in terms of a total system, embracing employees, equipment, machinery, and materials. Our success in manufacturing is due to the way these segments successfully interact.”

A similar perspective also characterizes relationships with those external to the company. All employees are introduced to the “mutuality of benefits” philosophy at the time of their employment. This philosophy calls for mutually satisfying exchanges (e.g., goods, services, and money) within the groups they transact with on a regular basis.

“We are a people-oriented company with a philosophy based on ‘mutuality of benefits’. Our success is the direct result of our unique relationship with our employees, suppliers, distributors, consumers, and the communities in which we work.”

Last, but far from least, there is a strong emphasis on innovation, risk-taking, and experimentation, emphasizing state-of-the-art knowledge and technology:

“The XYZ Research and Development facility is one of the most sophisticated departments of its kind. Our team of specialists has accumulated an extensive bank of knowledge and has the support of a worldwide group of researchers in our field.”

“We’re extremely proud of our Research and Development activities. It’s this group that is directly responsible for our remaining at the technological forefront of our industry.”
"XYZ manufacturing facilities incorporate trained employees, equipment, and technology that have established us as one of the most progressive companies in our industry."

"We are striving for an even more successful future—always willing to experiment, to innovate, to face new challenges with confidence."

In summary, the company views itself as people-oriented and open. It also sees itself as being an integrated system of individuals, technology, and materials that is itself part of a larger system which includes consumers, distributors, suppliers, and the community. Innovation, experimentation, information, and state-of-the-art tools are also critical elements in the company's expressed philosophy, goals, and means. This philosophy is widely and frequently disseminated among all employees—via orientation sessions and personnel manuals for new employees and reinforced by newsletters and workshops for continuing employees.

Ultimately, statements of company philosophy will influence employee behavior only if they are actualized in executive actions and decisions. An important means for codifying many of these actions and decisions is with formal policies, practices, and procedures. The following section addresses the extent to which Company XYZ exemplifies its philosophy and goals in formal policies.

POLICIES AND PRACTICES

The most noticeable and striking policies in this organization are those concerning punctuality. All employees, including the President, clock in every morning. Lateness is counted and added to unapproved absences and, at a certain point, lead to warnings and possibly termination. On-site presence is regarded as important for effective interaction and communication.

This policy pertains to all employees regardless of job level. Many employees mentioned this policy to illustrate that the company was egalitarian in practice as well as policy. Other practices that reinforce the impression of egalitarianism are the open office design and the first-come, first-serve rule for parking spaces (i.e., no spaces are assigned).

Within each hierarchical level (Figs. 1 through 5), bonuses are linked to both sales volume and return on assets, providing an obvious incentive for improved performance for the company as well as for the individual salaried employee. Salary information is public within the company as part of its open information policy.
As previously mentioned, there is at least an implicit policy to pay top dollar to hire the most highly educated and competent professionals and managers available. Educational assistance for the further development of their job skills is provided and employees are encouraged to take advantage of it. Lateral transfer from one department to another or between subsidiaries in the corporation is not uncommon and is generally perceived as an additional way to develop an employee's skills by providing him or her with a broad base of experience.

CONCLUSION

The impression that emerges from interviews and personnel data, together with company brochures and policies, is of a highly educated, well-paid, largely professional workforce employed by a dynamic, innovative firm that recognizes the importance of its human resources. Except for its formalistic policies on punctuality, the company closely resembles the "organic" (i.e., nonmechanistic) model of organizations that management theorists have touted for a number of years (e.g., Lawler, 1973).
IV. THE IMPLEMENTATION PROCESS

Five years ago the employees at Company XYZ relied on a very traditional mix of information resources. Now the firm has introduced—successfully, by its own estimation—a sophisticated and powerful array of electronic tools (described in Sec. V). This section describes the sequence of decisions and actions that intervened. The section first reviews the broad implementation philosophy at Company XYZ, relying directly on the Chief Executive Officer (CEO) interview. Then it details the strategy by which this philosophy was enacted, making use of material from interviews with a number of organization-level actors including the CEO, the head of the first implementation planning effort, and technical resource consultants. The section ends with a comparison of how these events unfolded from the perspective of the four focal departments, incorporating material from managers' and employees' interview responses.

IMPLEMENTATION PHILOSOPHY

In 1980 XYZ acquired a new CEO, who had a vision of the critical role for information systems in organizations, a vision that ties implementation success to broader organizational success. In the CEO's view, "success" can be equated with performance improvement. Performance improvement, he believes, usually comes from looking back at previous experience, manipulating and analyzing it in various ways, and ultimately learning from it. The key question is how information systems help, apart from whether they make use of computer technology.

An examination of familiar and admittedly useful information systems is instructive, according to the CEO. Closed systems like those used in accounting, for example, provide structures for recording financial events and getting immediate feedback about their effects. Open systems, as case law illustrates, likewise provide systematic ways of documenting events and thinking about them by way of analogy or precedent. In such very different instances, the CEO argues, having an information system is what permits retaining experiences, structuring and reasoning about them, and sharing and learning from the results. What computer technology can contribute is the capability to carry out these activities better, faster, and easier.
A successful organizational information system, the CEO contends, should permit a business to do those very things—to collect, store, structure, manipulate, and share information about previous experiences in order to learn from them and improve business performance. This vision became codified as "Growth Through Information, Experimentation, Communication," and permeated the implementation process.

THE BUSINESS PROBLEM

While an overarching philosophy guided the implementation process, it was motivated by a serious business problem. The segment of the consumer product industry in which Company XYZ operates is highly competitive, with many strong players. In 1980 XYZ, holding fourth place among its competitors, was facing major profit-and-loss difficulties; it needed to increase market share and cut costs. This impetus, given the presumed role of information systems in business growth, led to an investment in computer technology.

The goal was to replace old, rigid, batch-oriented information systems and manual technology with the latest flexible electronic tools, giving users a renewed sense of power, insight, and enthusiasm about their tasks, so as to organizational performance. This aim had some important corollaries. First, demand pull—XYZ's business need—instead of technology push would motivate system decisions. Second, the desired tools had to be good, for both doing and for learning. The system needed to be manipulable by users, who would pose questions, observe responses, and make judgments by modeling the relationships between them. Third, the technology should augment the worker rather than automate the work. Asking good questions, performing insightful analyses, taking the initiative, and making a decision are human skills that computers can assist but not replace.

THE PLANNING EFFORT

A high-level organizational actor (now a Vice President) was named to lead the planning effort and put together an implementation team. He chose three employees who had substantial business experience and a strong sense of strategy and who—like himself—were not systems professionals but were comfortable with information technology. He also recruited, for the team, an employee from another firm with recent systems implementation experience. The resulting five team members—who became the Business Systems Department—
collectively represented a knowledge of the organization's major business activities.

The team produced a business systems plan by first studying the work of the firm's many departments and identifying their information needs; this task required substantial input from department employees. Then it investigated the kinds of technology that might fill these needs. For this effort, the team relied heavily on advice and consultation from Technical Resource Consultants (TRC), an outside firm providing technical assistance for business systems development to several subsidiary companies in the corporate group of which XYZ is a member. Finally, in conjunction with TRC and user-department employees, the team developed a technical proposal that represented the completed business systems plan.

Looking back, the former head of the implementation team emphasizes the importance of both employee participation and technical expertise in the planning process. For answering questions about departmental information needs, he says, a direct knowledge of business tasks was critical. He contends that once a functional need is clearly identified, finding appropriate tools is not so hard; in contrast, making good decisions about tools when the task is unclear is impossible. On the other hand, scanning available technologies and making recommendations about what tools will best serve which needs required strong computer system professionals. For this purpose, access to TRC was extremely valuable. The implementation team was able to work well with TRC, in the view of XYZ employees, for two reasons. First, they say, TRC members are "bilingual"—they are technically knowledgeable but skilled at talking with people who are not. Second, TRC operates in the marketplace, unlike firms' internal information system departments; consequently, if it is to survive it has to be responsive to the needs of its clients.

THE IMPLEMENTATION STRATEGY

The year-long planning effort yielded an approved plan, and those who developed it were charged with implementing it. The team was given decisionmaking authority, continued access to employees and to technical resources, and responsibility for bringing in the right tools for identified needs. The implementation effort that followed was—and continues to be—an iterative process with a number of salient characteristics:

- Support of executive management
- Flexible, project-by-project planning
- Varied technical resources and constraints
- Experimentation and risk-taking
- Evolutionary view of implementation

**Support of Executive Management**

Executive management was highly committed to the process and provided solid budgetary support. Its importance is evident in the apportionment of total systems expenditures to date:

- 10% hardware
- 10% software
- 30% software development, modification
- 40% implementation
- 10% training

Here implementation includes meetings, information gathering, planning, and task restructuring—the labor-intensive steps involved in fitting technology to work functions and vice versa.

**Flexible, Project-by-Project Planning**

The process operated on a project-by-project basis, with the plan partitioned into relatively independent parts. At any given time, the team chose a mix of some simple projects (easier, short-term) and some complex ones.

The plan established a general blueprint and performance criteria for system development, but was indeterminate with respect to order of projects and details of their enactment. Each project undertaken required its own detailed design.

Projects still originate either from user groups (who propose and justify them) or from TRC when it perceives a need it believes it can fill. (If TRC initiates the idea, it must sell it to the user department.) In any case, each project requires its own plan and justification; the implementation team reviews and acts on the basis of nominated projects. Both user groups and upper management estimate there is about an even balance between bottom-up and top-down project origination.

**Varied Technical Resources and Constraints**

Varied technical resources and constraints entered the process. A centralized computing facility operated by TRC enabled this mid-size firm to make use of more computing resources (power, storage, systems, and expertise) than it could support on its own. Further, to link
local users with technical experts more tightly, XYZ began in 1982 to retain an on-site TRC support staff.

Relying on centralized external resources also constrained the company's autonomy. TRC, for example, chose the equipment, operating systems, and general utilities for its mainframe computer. Client companies such as XYZ must then choose hardware with host-compatible central processing units (CPUs), storage media, and communications. On the other hand, client companies may choose any software that will run under the mainframe's operating systems (e.g., SAS), and TRC becomes responsible for maintaining and updating them.

For many purposes, the constraints are not unduly limiting—especially given the proliferation of portable modular software. When these constraints pose problems, XYZ turns to other alternatives. They may rent time on other systems (see discussion of EXPRESS, below) for large computing needs not met by TRC. Or, for smaller tasks (e.g., project management), they may purchase microcomputers to fill the gap. If these options are chosen, updating and maintenance are handled in-house.

**Experimentation and Risk-taking**

XYZ recognized that technological innovation entails experimentation and risk. No one can predict exactly how new tools will work out; in many instances, employees found unanticipated and productive applications or generated valuable modifications. In other instances, new tools prove to be not very useful and were discarded—managers estimate this happens about 25 percent of the time. In still other instances, new tools not anticipated in the planning activity appeared on the market. Taking advantage of the emergence of low-cost PCs, for example, required reconsidering many system design issues, not all of which have been resolved. These cases are not regarded as wasted expenditures or planning failures, but as part of the learning process.

**Evolutionary View of Implementation**

Finally, implementation was not envisioned as a short-term effort with a finish-line, but as a continuous evolutionary process. That view had important implications. First, the system was designed to accommodate continuous modification, extension, and upgrading. This is coherent with the belief that there is not always a "right answer" to system questions, especially for an organization learning how to use new electronic tools as the technical state of the art is advancing.
Second, the organization is prepared for change. It has not tried to impose suboptimal stability in order to achieve "postimplementation" equilibrium.

The project portfolio comprising the initial business plan will be completed during 1986 but systems development will continue, relying on the change-mechanisms now in place. Viewed retrospectively, the implementation process to date is judged a success. Says the CEO, "No one in the industry is within five years of us."

DEPARTMENTAL INCENTIVES

At the broad organizational level there were explicit reasons for introducing computer-based information systems into the working life of its component departments. Interviews were designed to probe how widely and explicitly these goals were shared and what specific forms they might take within the four focal work groups. We found highly congruent incentives for adopting the new what technology at both departmental and individual levels. The theme, expressed in myriad ways throughout the firm, was performance improvement.

For all participating departments, decision support was emphasized. Whether for production planning, marketing, product development or financial control, the installed information systems permitted them to carry out better analytic work than before, to make assumptions explicit, to experiment with the models underlying their judgments, to attain new task insights, and to base actions on wiser decisions. In addition, these groups found that online work allowed them to access more information as well as to integrate information from different sources, and to use information more flexibly. Further, they were all impelled toward system use by the timeliness and accuracy of data and by the savings in time and effort it promised.

Against the background of shared incentives, departments differentially emphasized different objectives. For example, improved timeliness is of special importance to the Controller's office for rapid payment processing and up-to-date budget analysis. Flexibility is more strongly emphasized in Planning—particularly the ability to revise plans so as to avoid planning disasters. For Marketing Research more than for other departments, the elimination of cumbersome paper- and microfiche-based procedures serves as an incentive. Finally, the Product Development department appears to have the most highly motivating application per se. A unique formula generation system allows them to work on product maintenance and product design in ways they could not before: They can, for example, model and observe formula-
ingredient interactions; ask the system to suggest formulas that meet
certain desired criteria; and respond rapidly to changed externalities
(e.g., changed availabilities or prices of commodities) without risking
product quality or consistency. New electronic tools have become
almost inextricable from job functions in R&D.

These kinds of incentives were re-echoed at the individual level,
where employees stressed high performance as intrinsically motiv-
vating. The people we interviewed especially value computers be-
cause they enhance their performance. Technology for its own sake
has little appeal.

Employees mentioned several other incentives for using the com-
puter system. Users took pride in acquiring new skills. Some were
surprised by their own abilities, most found the learning experience
exciting, and in each department a few became teachers as well as
learners. Many individuals mentioned the enjoyment of working in a
dynamic information environment. Tasks became more interesting
with an interactive system that can support ad hoc restructuring of
information, spontaneous pursuit of queries, and immediate inspection
of the results. Finally, the system opens the way for people to experi-
ment and innovate—opportunities that everyone, believes will yield
performance pay-offs in the long run.

The prevailing consensus from CEO to clerk, then, is that computers
enable people to tap into systems of knowledge and experiment with
them in ways that produce tangible benefits for everyone.
V. TECHNOLOGY AND TRAINING

Computer technology at Company XYZ is both sophisticated and multilevel. A variety of hardware, from large mainframes to personal computers, supports many different functions such as word processing, data integration and analysis, product decisionmaking, sales forecasting, and project management. The resulting information system is used by many employees at different skill levels. The term "computer system," in fact, is misleading: Many separate systems operate in conjunction with other information technology, such as Voice Message Exchange (VMX).

In this section, we first provide an overview of these systems, including the hardware, databases, applications, support mechanisms, and systems security. We then describe more fully the systems and their uses in the four focal departments. Finally, we discuss employee training. We obtained information about technology and training from interviews with three technically knowledgeable individuals: a Business Systems manager and two employees in the outside technical consulting firm—plus managers and users in the four focal departments.

TECHNOLOGY OVERVIEW

Primary Computer Systems

Table 2 summarizes the computer systems and databases used by the departments under study (both focal and linking departments). The major architectures include a remote IBM mainframe owned by TRC and used by XYZ on a timeshare basis; a Prime computer on which time is also rented; and a growing number of personal computers (PCs). There are three general sorts of systems on the IBM host: Commodities and Ingredients (Materials); the Distribution Control System (DCS); and the General Ledger. Information stored on these systems is accessed and manipulated through a variety of operating systems (MVS, TSO, IMS), programming languages (e.g., FORTRAN, BASIC, Ramis, Script, Forsight, EXPRESS), and applications software (e.g., SAS, spreadsheets, text editors, graphics packages). About 100 terminals are now available to XYZ employees (up from only 16 three years ago).

The Prime computer runs EXPRESS, a fairly high-level, matrix-structured language suitable for flexible data manipulation, analysis,
### Table 2

**COMPUTER HARDWARE, SYSTEMS, DATABASES, AND USER DEPARTMENTS**

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<tr>
<th><strong>IBM</strong></th>
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<td><strong>Materials System</strong></td>
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<td>Databases</td>
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<td>Formulas</td>
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<td>Experimental data</td>
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<td>Ingredient characteristics</td>
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<td><strong>Distribution Control System</strong></td>
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<tr>
<td>Databases</td>
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<tr>
<td>Orders</td>
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<tr>
<td>Inventories</td>
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<td>Shipments</td>
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<tr>
<td>Billing</td>
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<tr>
<td>Traffic movements</td>
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<tr>
<td><strong>General Ledger System</strong></td>
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<tr>
<td>Databases</td>
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<tr>
<td>Shipments</td>
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<tr>
<td>Costs</td>
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<tr>
<td>Accounts payable/receivable</td>
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<th><strong>PRIME</strong></th>
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<tr>
<td><strong>Databases</strong></td>
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<tr>
<td>Shipments</td>
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<td>Warehouse sales</td>
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<tr>
<td>Distribution tracking</td>
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<td>Production scheduling</td>
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<td>Retail sales</td>
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**PERSONAL AND PORTABLE COMPUTERS**

<table>
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<tr>
<th><strong>Databases</strong></th>
<th>User departments</th>
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<tr>
<td>Individually created or downloaded as needed</td>
<td>Controller’s Office</td>
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<td></td>
<td>Brands</td>
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<tr>
<td></td>
<td>Planning</td>
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<tr>
<td></td>
<td>R&amp;D</td>
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<td></td>
<td>Sales</td>
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and reporting, which supports decisionmaking. EXPRESS is used to access both inhouse data (such as factory shipments) and syndicated data (such as retail sales). Data are maintained and updated by system support personnel in the Business Systems department, or by the individual who makes exclusive use of a particular database. The Sales and Distribution Planning Supervisor, for example, has responsibility for updating the Promotional database.

Further, some departments use personal computers. Databases are not regularly maintained on PCs, but analysts can download data from EXPRESS or from experimental product trials to PCs, which have better statistical and graphics applications. In the other direction, experimental data from the company's R&D laboratories are entered onsite at PCs and uploaded to larger systems. (Managers also have administrative uses for PCs, to be discussed below.) In addition to these PCs, smaller portable computers are in use by sales representatives. They can download data onto these and use them to make limited queries for demonstration and sales purposes when calling on buyers at retail firms. Buyers, for example, can be shown the volume of retail sales in their stores accounted for by XYZ products in the past month in comparison with sales figures for other products.

Some systems are linked to provide different data to different departments. For example, product shipment data, which start in DCS, are periodically aggregated and sent to the Prime computer, where the Planning Department uses them to assess future inventory needs. Other shipment data may be downloaded to PCs used by the Controller's office for updating accounts receivable. Another example is provided by sales data. Key items of information may be used in the operations side of Planning to generate sales forecasts. While in EXPRESS format, sales data are also used for production scheduling; the outputs are then reported to the manufacturing plant. The same data are used by the Planning Department clerk, who accesses them through the Gross Materials Requirements (GMR) system under TSO to produce GMR reports. Both the Product Development and Commercial departments subsequently make use of reported information about future materials requirements.

Other Systems and Applications

Word processing is done by a small centralized department that handles internal and external correspondence for various departments through their departmental secretaries.

Electronic mail is used, but primarily for external communications with remote plants and other companies. For a variety of reasons, it
has not been fully implemented within XYZ. With help from TRC, the company conducted two experimental trials with internal electronic mail; they first tried the Burroughs E-Mail system, and then the IBM PROFFS system. They found drawbacks to both systems and discontinued their use. Moreover, most employees do not have their own terminals, and even those who do are not continuously logged on. Further, no one has been able to cost-justify internal electronic mail. Finally, electronic mail is seen as hindering personal communications, which are essential elements of XYZ’s business strategy.

XYZ does, however, use Voice Message Exchange (VMX) to better manage telephone communications. Primary VMX communication occurs between sales representatives in the field and the Sales Planning department in the home office. Currently, about 50 employees use VMX. The Information Services department is trying to solicit grassroots support for increasing the use of VMX.

Support Mechanisms

System support comes from two sources: TRC mainly supports IBM-based systems, while the Business Systems department supports non-IBM systems and coordinates the many systems within XYZ. TRC operates a large IBM computing facility which serves both XYZ and a number of other companies. Because XYZ has become such a large user, TRC now maintains an on-site user support office there. TRC is responsible for supporting, updating and maintaining the major online systems at XYZ.

Although TRC consults and advises the company about non-IBM systems, major services for the EXPRESS system are provided by the system vendor and the Business Systems department. Business Systems’ larger mission is to identify information tools that meet business needs, to evaluate their costs and benefits from the corporate perspective, and to help make them a reality. Business Systems is also responsible for integrating the systems currently in use. One goal is to link the General Ledger to financial planning on EXPRESS. Another is to integrate inhouse corporate databases with syndicated databases. A third is to convert data used by Product Development into EXPRESS-readable form so that analysts can bring that high-level language to bear on their work (currently they use SAS, a more procedural language).

The implementation of PCs is unsystematic, and neither TRC nor Business Systems has formal responsibility for their support. PCs are purchased by XYZ on employee request. In this way, the company maintains control over PC expansion. Since policies regarding PCs
and their long-term use and place in the company are still evolving, standard support mechanisms are not in place.

TRC and Business Systems both provide training and technical support. Both are responsible for training users on major mainframe applications. TRC runs a help desk at which users can ask questions about any company system. Users are then directed to individuals who can help them with their problems. Business Systems handles formal training and informal coaching on EXPRESS; employees usually take formal courses from the system vendor. Departments currently have responsibility for PC training and, within departments, de facto experts have informal responsibility to train peers on advanced or infrequently used applications. Business Systems provides a few PC-related services, such as downloading data from EXPRESS or helping interested employees locate PC training courses.

System Security, Reliability, and Availability

The employees we interviewed in both TRC and XYZ's Business Systems Department were not aware of any data security problems. There is elaborate security to prevent unauthorized access in the IBM environment, and EXPRESS users need passwords. Only a few people have more than read-only access to corporate databases. System security is, however, an important reason why the company currently maintains control over PCs.

There seem to be few problems with system crashes or downtime. TRC usually warns the users of IBM-based systems about times when a system will be down. Some problems were incurred with large-scale system crashes in the past, largely due to down connectors to the host computer thousands of miles away; the organization learned from these incidents and now has the necessary system back-ups.

On the whole, the EXPRESS system on the Prime computer is also fairly reliable. Employees in the Market Research department noted some downtime problems, however, particularly during the two days per month when Planning is working on end-of-period reports. This creates an overload of users on EXPRESS, and employees in Market Research have had to adjust their work to accommodate this problem. In addition, downtime is a problem when databases are being updated.

Response time on EXPRESS is adequate to fast, depending on the number of users logged on. Slowness is more of a problem on the IBM systems, especially during peak times. Users in R&D had the most complaints about response time; one user estimated that he spent about 30 percent of his computer time waiting. However, an R&D
manager contended that these kinds of delays are notable only because without the computer they would never schedule their work so tightly.

Sharing workstations is more problematic than downtime or slowdown for at least some users in three of the four departments (see below). Since few interviewees use the computer every day, and even daily online work may be very limited, it seems reasonable from an organizational perspective that it is unnecessary for each person to have his or her own workstation. On the other hand, when a company pays top dollar for good people, it also seems reasonable to provide enough workstations to eliminate person-time spent in waiting, sharing, and task-queuing. The tradeoff, then, is one of cost versus access, and it has not been wholly resolved (see App. B, Issue #8 for further discussion).

TECHNOLOGY IN FOUR DEPARTMENTS

Below we provide a more detailed description of the uses of information technology in the four focal departments. We consider such issues as individual differences in experience and use, major applications, system modifiability, and users' overall assessments of their systems. Appendix C contains four vignettes illustrating how employees in the four departments typically use the information system in their information work.

Experience and Use

Length of experience with computers varied widely among employees at the time of interview (see Table 3). The average was three years. Employees in Market Research had the most prior experience.

Among 20 interviewees in four departments, 5 had their own workstations. The remainder shared workstations with two or more others. For some employees, the lack of workstations was problematic. One user mentioned "lots of fighting" to get on the system. Another reported coming in very early and organizing the work to be done in big blocks of time to ensure her continued access when deadlines approach. Consequently, she spends a great deal of uninterrupted time online. She takes breaks infrequently since it might be difficult to get back on the system. Still another had asked for his own workstation, but has not received it because there is no room in his space. Other employees coordinate their work to accommodate sharing; they work on the same tasks and are aware of each other's schedules: The person with the highest-priority task goes first.
Table 3

COMPUTER EXPERIENCE OF INTERVIEWEES IN THE FOCAL DEPARTMENTS

<table>
<thead>
<tr>
<th>Experience</th>
<th>Market Research</th>
<th>Planning</th>
<th>R&amp;D</th>
<th>Financial Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Years (Range)</td>
<td>3.5 (18 moe-5.5 yrs)</td>
<td>2.7 (14 moe-2 yrs)</td>
<td>4.0 (1-7 yrs)</td>
<td>4.3 (2.5-6 yrs)</td>
</tr>
<tr>
<td>Number with prior computer experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) None/minimal</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>(b) High school, college</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>(c) Other jobs</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>(d) Both (b) and (c)</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
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</table>

It appears that in most departments workstation allocation reflects task demands. In one department, however, status is also a factor in resource allocation. For instance, the department supplies higher-level managers with PCs. Lower-level managers and professionals share terminals to a host computer, logging in at the closest one available. However, there is some attempt to locate workstations where the need is likely to be greatest.

Actual time spent working on the computer was extremely variable across the four groups. In Planning, for example, one manager worked online only six days a year; one employee worked 2 to 3 hours every day; others might work online every day for two months, then not at all the next month. Individuals in this latter group tended to work 6 to 7 hours at a stretch when online. This variability was largely due to the nature of individual jobs and to higher work demands at periodic times (e.g., when end-of-period reports are due).

Applications

The applications of the four departments vary widely, of course. Rather than summarize across departments, we provide a brief overview of the major applications in each, and a typical example. (Appendix C provides more detailed illustrations.)

Market Research primarily uses EXPRESS to access and analyze data (e.g., consumer purchases, other sales data, factory shipments),
and to write and format reports. It accesses a syndicated database containing consumer buying behavior on a timeshare basis through another company.

Operations Planning uses EXPRESS for sales forecasting; employees examine shipments, promotional activities, and other historical data in order to project similar future events and their consequences. EXPRESS is also used to input and analyze data that are not online, particularly on the business Planning side. One employee primarily uses hard-copy data, but relies on EXPRESS for very large computations. He was hoping to get more of his data online in the future. The Planning department clerk uses EXPRESS-generated analyses to write Gross Materials Requirements reports.

TSO and IMS are major operating systems used by Product Development in R&D. IMS is a special system written for this firm; it is used for formula generation and optimization as well as material planning and control, and it accesses very large databases. TSO is time-shared and is used to run statistical analysis programs to support a number of other applications (graphics, word processing). Both VS BASIC and SAS run under TSO; SAS is used by most people in Product Development for their own analysis and experimentation. A number of other fourth-generation statistical packages are also available, which reduce the need for external programming resources. Finally, the department manager uses graphics and spreadsheets on the PC. These applications support project planning and tracking; they are particularly helpful for continuous modification of schedules and budgets, and for reconfiguring critical paths.

In the Controller's Office, the software serves financial and accounting purposes. Within this general domain, applications range widely in terms of function, complexity, and level of skill required: from posting charges, reviewing customer accounts, applying checks to invoices in their accounts, and writing general ledger reports, to financial forecasting, planning, and special analyses and decision support. This reflects the range of skills, job levels, and responsibilities of our respondents—from clerks to account managers.

System Modifiability

The systems available to focal departments vary in their modifiability. EXPRESS is essentially user-guided; users can, for example, write programs to create models or perform needed analyses. In both of the departments with heavy EXPRESS use (Planning and Market Research), employees take differential advantage of modification procedures. Some users frequently write their own programs. This allows
them, for example, to customize reports through alterations in format, graphs, and title changes. Other users either use existing programs as is or modify them slightly. The tendency to modify or write programs did not appear to be related necessarily to experience or skill. Although one department "technophile" wrote a set of programs for the department to use, he had no more training or experience to begin with than did the employees who borrowed these applications. He enjoyed working on the computer and had become highly proficient at it. In Planning, where work is often deadline-driven, two employees felt there simply was not enough time to become more computer proficient.

The TSO operating system is both fast and flexible, and R&D users have a great deal of control over the applications they bring to bear on their work. In contrast IMS, a system developed exclusively for company XYZ, is slow and cannot be user-modified (e.g., no customized reports); changes are expensive to make and may take six months. However, some large-scale formula-optimization tasks can be better performed on IMS. Employees choose between the two systems depending on the demands of specific tasks. TSO, for example, is more adaptable to looking at small subsets of data in a particular way—such as effects of possible substitutions of ingredients in a formula. Once the choice between ingredients has been made, applications on the IMS system are used to optimize the final formula. Employees using these systems regard them as essentially user-driven, though this judgment varies from application to application. Again, the extent to which users will modify system behavior appears to be largely a matter of their own needs, interests, skills, and confidence.

Four of the five employees working with the General Ledger in the Controller's Office described the system as essentially menu-driven. Although one of the four thought it was possible to "get around the menu," another claimed it was not. The only feature readily amenable to user modification is the Variable Report Writer, which allows users to access and format data in any way they want.

In sum, users in most departments have a range of options for guiding and modifying the systems they employ. This permits considerable choice about how to use the advanced tools. However, since these choices are left largely to user initiative, some employees envision a split between "haves" and "have nots," based on differential aptitude for information technology.

System Evaluation

Employees in the four departments were generally enthusiastic about the capabilities of the computer systems. Users of both main-
frame systems communted on their flexibility for manipulating, interpreting, and reporting data, on the variety of applications available, and on the capability they provided to access up-to-date information.

Complaints about the systems they use also came from users in the Controller's Office, Market Research, and Planning. For example, poor graphics capability, a mediocre statistics package, a difficult interface to numeric computation, and difficulty moving between databases were cited as disadvantages of EXPRESS. Employees solve some of these problems by downloading data to and working on PCs.

Other complaints concerned the databases themselves. Data were sometimes inaccurate or unavailable—EXPRESS databases, for example, can only hold two and one-half years' worth of information. In addition, some employees did not like taking the time to maintain and update some of their databases. This task allocation reflects the company's decision to distribute such chores among users rather than create repetitive data entry jobs.

Users in three of the four departments desired better integration between the major systems. R&D, for example, wanted to link the formula generator with the planning system, devise an improved link to the manufacturing plant, and create procedures for mapping large EXPRESS databases into SAS format for querying. Planning Department users hoped for better integration between PCs and the General Ledger and EXPRESS databases.

By and large, however, the computer systems received kudos from most users. The disadvantages cited by users have more to do with lack of systems integration than with problems in the individual systems. Moreover, the integration problem had been recognized and planned for as an expected phase of systems implementation. That integration is an issue at all, and that its inevitability was anticipated, are important signs of XYZ's advanced stage of technology implementation.

**TRAINING FOR USE**

Although we conceptualize training as part of implementation, we describe it after presenting an overview of the technology because it cannot be well understood apart from the information tools themselves. In this section we examine users' viewpoints on training as gathered in employee interviews. We discuss similarities and differences between departments on such issues as whether training is voluntary; the type of training offered; formal and informal learning support; and opportunities for long-term learning.
Voluntary or Mandatory?

Generally speaking, for most employees below the department managerial level, learning about and using the computer systems is part of doing the job. However, learning anything beyond the minimum required for this purpose is voluntary. Managers in three of four departments were not regular users of the systems employed by their subordinates. Further, one supervisor was not a computer user; he had two analysts who supplied him with the information he needed. He asserted that learning to use computer systems was voluntary.

It may be that as system use grows and the implementation of advanced information tools proceeds, jobs and tasks may become restructured so that it will become necessary to use computers, not voluntary.

Structure of Training

Training varies somewhat by department. In R&D, the tasks are so specialized that general purpose introductory and intermediate courses (e.g., for using the text editor) are of little help. Further, since new employees enter infrequently, there are rarely enough people at the same level of learning at the same time to justify a class. So training proceeds on an individual basis, with peers. In the beginning a new user spends several days with peers, in on-the-job training. Peer learning also characterizes the Planning department, where one of the systems is used by only one person. She was trained by the programmer who developed the system and by her supervisor.

Users of EXPRESS can attend formal classes offered by the vendor. Beginning EXPRESS classes stress concrete operations; advanced classes include model-based understanding. Learners' perceptions of course goals included getting people to use the computer and breaking down psychological barriers. Users were encouraged to experiment with their systems.

Finally, self-instruction is another training mode. One employee, who arrived before classes had been initiated, learned about systems at XYZ on his own by reading manuals and asking for help when needed.

The amount of time required for users to learn their systems varied widely. In R&D it took 2 to 3 months for new employees to become comfortable using the main applications. In Planning, some applications could be used in just a few days, and users felt comfortable after about a month. The sales forecasting system, however, took about six months to master.
Formal and Informal Help

Across departments, users mentioned a variety of formal help mechanisms, including documentation (for both Prime and IBM systems), a technician for help on the IBM mainframe, a telephone help line, the EXPRESS Users Group, and online help. These means of assistance, however, were not equally reliable. Employees had problems finding some of the manuals they needed, and some operations were not well-documented. Some interviewees regarded technical help, both online and in person, as too technical to be truly helpful for inexpert users.

Informal support was crucial to most users in three of the departments. Two departments had EXPRESS “experts” who wrote programs for other users and provided regular training and technical assistance. An SAS “expert” in R&D judged that he spent about half an hour a day teaching or conferring with other users in the department about how to do something on the computer. These “experts” performed a voluntary support service; training and programming was not part of their job. In one department, users were asked not to rely on a particular “expert” so much, and he was asked to be less helpful. Many users said their department “expert” was preferable to the technical people available through either TRC or Business Systems.

Long-term Learning

After initial training, users may take formal classes to increase their skills or learn informally by whatever means they choose. Advanced EXPRESS courses are offered externally; interested users can take them at the company’s expense. When a new system has been installed, users have been sent outside to learn it or have attended in-house courses. Furthermore, employees can request and usually receive reimbursement for any course as long as it is relevant to their job, but few have done so. Some have been too busy and others merely have not gotten around to it.

Much long-term learning is informal and proceeds at the user’s initiative. In R&D, for example, the learner must find someone who is willing and able to teach a particular task, and then find a time when they are both free. Other informal learning is planned and organized. An employee in Market Research, for example, was informally trained as a backup for the department “expert” on the Prompt database.

Evaluation of Training

Most users are well satisfied with the mix of formal and ad hoc training procedures. Generally, EXPRESS has the best training and
user support, because it has the largest user base. Support for other learning, such as the Ramis language, is less forthcoming, although there is a technical expert on site. Users were not happy about the lack of PC support, contending that it is too casual and scanty. One employee took it upon himself to train others interested in PCs. Another thought that the training function handled by Personnel could provide more PC support.

The assessment of training is more complicated from the perspective of experienced users who serve as teachers. For employees who do peer training, there is nothing in their formal job descriptions that takes account of this role—or in their official work schedules. They simply try to find the time to fit in user training or assistance, making trade-offs between what they have to do for themselves and what they believe they should do for others in the department. While they seem to enjoy the teaching role, they believe that learning support could be more effectively provided if some resources within the department were formally allocated for that purpose. A resource center was one suggestion for bringing some organization to the current catch-as-catch-can approach.

In sum, training is eclectic and adaptive to the needs and skill mix of each department. How it proceeds depends on the task to be learned, the number of users who must learn it, and the resources on hand or externally available. Beyond a minimum level, it is usually the user's responsibility to get the training needed or desired in order to do a better job or advance to a different job. Department "experts" play a key role in this process, even though it is beyond their formal responsibilities. Although time for learning by formal means is allocated, time for informal learning and teaching is not (see App. B, Issue #11, for further discussion of training issues).
VI. IMPACTS AND ANALYSIS

This section first summarizes the impacts of computer-based procedures for individuals and groups at XYZ. These accounts are based chiefly on interviews with managers and employees of focal departments and linking actors.1 We then use the conceptual framework drawn from prior innovation research to suggest reasons for the success of XYZ’s introduction of advanced information tools into its work.

IMPACTS ON INDIVIDUALS AND GROUPS

Table 4 summarizes responses to the employee-level interview questions addressing the impact of the computer systems on users. (See App. A for the questions asked.) Each of these items is discussed in turn.

Changes in Work

Responses to separate questions concerning changes in variety and in control are combined into a single “enrichment” dimension since interviewees frequently did clearly distinguish between the two. They often cited an example of increased control when asked about changes in variety. By “enrichment,” then, we mean changes in the intrinsically motivating properties of a job, including both variety and control. The most frequently mentioned examples were increased flexibility in scheduling, planning, and performing work, and improved access to and ability to manipulate critical information. As the table indicates, the majority of users except for those in Market Research felt that their work had been enriched by computers.

There was much more variability in response to the question on total work demands, however, both within and among groups. This variability apparently arises from different responses to the increased time savings reported by almost all users (discussed in more detail shortly). Since they were able to finish their work sooner, some users were bored because of the extra time on their hands; others used the extra time to take on new responsibilities and projects, to do new technical tasks

1Potentially conflicting views emerging in the interviews were probed in more detail during feedback sessions conducted at the research site several weeks after the interviews were concluded; they are discussed further in App. B. These issues are identified in the discussion of impacts as appropriate.
# Table 4

**IMPACTS ON INDIVIDUALS AND GROUPS**

<table>
<thead>
<tr>
<th>Question</th>
<th>Impact or Response</th>
<th>Controller</th>
<th>Planning</th>
<th>Market Research</th>
<th>Product Development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>More</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Same</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Less</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Demands</td>
<td>More</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Same</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Less</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Reinvention</td>
<td>Yes</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Changes in management style</td>
<td>Yes</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>2. Communication changes</td>
<td>Yes</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Go back to old ways</td>
<td>Yes</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Productivity (time savings)</td>
<td>More</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
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<tr>
<td></td>
<td>Less</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
</tr>
</tbody>
</table>

5. Problems, Complaints

| Physical                              | Yes                | 2          | 3        | 3               | 3                   |
|                                       | No                 | 3          | 2        | 2               | 2                   |
| Psychological                        | Yes                | 3          | 0        | 3               | 1                   |
|                                       | No                 | 2          | 5        | 2               | 4                   |

6. Formal job changes

| Yes                                   | 1                  | 0          | 1        | 1               |
|                                       | No                 | 4          | 5        | 4               | 4                   |

7. Job satisfaction

| More                                   | 5                  | 3          | 3        | 5               |
|                                       | Same               | 0          | 1        | 0               | 0                   |
|                                       | Less               | 0          | 1        | 2               | 0                   |
(e.g., training and programming), or to respond to increasing requests for more of what they had done before (e.g., more analyses and reports). As a result, total work demands increased for some, or remained unchanged, or decreased—depending on goals and functions of the work groups, design of the jobs, and the initiative and motivation of users.

Groups also differed in how users redefined their jobs or even invented new ways of doing their work as a result of the time gained through faster and more efficient computer-based procedures. Most interviewees reported either “task reinvention” (developing applications or helping others) or “tool reinvention” (innovative adaptation or modification of the technology itself, such as developing programs that enable them to do a task more effectively). Task reinvention was more frequently reported in general, and tool reinvention was apparently greater in Product Development than in the other three departments. This may reflect the more technical nature of their work and skills. In any case, it is important to note that employees themselves mainly determined the new responsibilities, tasks and tools they needed to perform their work effectively. (See App. B, Issue #3 for further discussion.)

A change in management style was reported by only one focal department, Market Research. The manager of this department was spending much of his time online and less of his time in more typical management activities (e.g., directing others). Opinions of interviewees in the group about whether this change was good or bad were mixed: One employee thought the manager had become less accessible; others thought the manager was innovative and had a visionary approach in finding more and better ways to use the technology. The general issue of management style vis-a-vis computers—how much of their time should managers be spending online—was addressed in the feedback sessions. As these sessions revealed, the answers depend on what is needed for effective work group performance (see App. B, Issue #2).

**Changes in Communications**

Most changes in communications resulted from tool sharing and interactions with others in the department related to getting help or informal training to use the computer, or to solving problems concerning an application or task. The only group that reported increased communications with those outside their department was the Controller’s Office (plus one user in Market Research). They have more communication with employees in other companies who use TRC’s system and services. They also get more requests from
employees in other departments for information about accounts, customers, and the like.

A particularly important interpersonal phenomenon was reported by Product Development and Market Research: the emergence of two potentially antagonistic groups, information system non-users and users, with different norms and values. This had not yet led to any actual divisions, but was a worrisome enough possibility to stimulate comments by several users. As a result, this issue was also included in feedback sessions to determine how serious this problem might be and what its potential implications are (see App. B, Issue = 1).

Could They Go Back to the Old Ways?

In only two departments did any users say they could go back to the old ways of working. Two users in planning believed it was possible to go back, but one preferred the new technology and the other only occasionally worked online. In Market Research, only one user would go back to the old way of doing things. In this person's opinion, the technology provided access to data not needed in more traditional approaches to market research.

Differences in Productivity

All departments believed that computers had increased productivity, primarily because they enabled people to do their work faster. Interviewees also cited rapid access to critical information, and faster reaction to price shifts, commodity scarcities, and other changes in the business environment. With the time saved, more data can be analyzed, more creative inquiries pursued, better decisions made, and more reports drafted. Other outcomes mentioned included increased flexibility, quality, and cost savings.

However, one user in Planning felt that greater speed led to poorer quality work because managers could pressure employees for more and faster—but perhaps less thoughtful—work. Another view was that analysts were not as productive as they could be because of time they spend on data management instead of analysis. A user in Market Research similarly expressed concern that speed in data gathering might result in increased demands for data without increased demands for analysis. As a result, this user felt the job had become more routine and less motivating, and that these effects would lead to reduced productivity in the long run (see App. B, Issues #3 and #9, for additional discussion).
Physical and Psychological Impacts

Physical complaints were mentioned by at least two or more users in all four groups. The complaints included eye, neck, or back strain; headaches; sore fingers; dry eyes; and visual afterimages (with eyes closed) persisting after the end of the workday. Stress and other psychological effects were mentioned by users in all groups but Planning; however, no consistent cause or pattern was evident. Some of the reasons frequently cited included initial fear of the computer (which has since been replaced by confidence), or deadlines coupled with computer crashes, downtime, or slow response time. Finally, some users mentioned difficulty in concentration when a shared terminal is in use near their desk (see App. B, Issue #6).

Changes in Formal Job Titles, Descriptions, and Levels

Formal job changes were reported in three of the four groups (Planning, excepted), but only at the Clerk level. The two Clerks in the Controllers Office believed their recent promotions and pay increases were due to increased responsibilities and special assignments resulting from their computer use. The Clerks’ job descriptions in Market Research and Product Development were being updated at the time of the interviews, explicitly because of new computer-related, and therefore higher-level, skills and responsibilities. (In Product Development, that position had been upgraded from hourly to salaried by the time of the feedback session.)

None of the salaried employees we interviewed have experienced nor expect to experience such changes in the immediate future, except to the extent that computers enable them to perform more effectively. They seem to view the computer as a tool instead of as an agent that changes the fundamental nature and functions of their jobs (e.g., analysts still analyze and managers still manage, although the ways in which they perform these functions may change). Furthermore, they did not believe that computer skills per se will or should lead to promotions and advancements unless these skills cause work performance to improve. As the feedback sessions subsequently clarified, the determining factor in changes in job titles, descriptions, and advancements should not be the sheer adoption of technology but the degree to which it changes the nature of tasks and responsibilities (see App. B, Issues #4 and #10). The role of Personnel Departments with respect to these and related issues was also addressed in the feedback sessions (Issue #12).
Changes in Job Satisfaction and Opportunities for Advancement

Most users in all groups reported increased job satisfaction but responses were more variable in Planning and Market Research. In the latter groups computers were seen as a mixed blessing. While some users found self-satisfaction and a sense of accomplishment from increased computer-related knowledge and improvements in the ability to do their jobs, others were bored, less motivated, and thought they were working below their abilities. One of the reasons cited for dissatisfaction in Planning was frustration when the technology failed to live up to the great expectations that had been held out for it. Another user felt “locked to the terminal” when trying to meet end-of-period or other deadlines.

Sources of satisfaction in the other groups included the belief that “I can do projects and not worry about the integrity of the data,” a perception that management is now more open, the excitement of learning, feelings of achievement and mastery, and more stimulating and creative work.

IMPACTS ACROSS GROUPS

Probably the most important impacts for the organization as a whole are those we did not find. We saw no trends toward the mechanization of work or the deskilling of jobs that have occurred elsewhere. We generally found the opposite: Users reporting that computers increased the variety, challenge, creativity, and responsibility of their jobs.

Most employees use the time gained through advanced information tools to take on new tasks and responsibilities. On occasion, groups have also widened or redefined their missions. Equipped with comprehensive information tools, the Market Research department, for example, now envisions its scope to include everything from the time they order the materials until the product is consumed. The Industrial Engineering department, a plant-based group that frequently interacts with a focal group in the study, has redefined its mission to take in work “where the rubber meets the road.” That is, making use of technical skills within its own staff, it is helping a focal department with PC implementation and training, filling a gap in support services. This function was too small and short-term for TRC or for contracting to an external services vendor, so linking-actors in Industrial Engineering stepped in to provide technical assistance.
In addition to "local" innovation on the part of individuals and groups, we also observed the development of significant "local" expertise. This expertise takes two forms. Most or all work group members exhibit a higher skill level, typically computer system knowledge that has been internalized and operationalized as a method of doing work. In contrast with having a technical department where all the expertise resides, expertise at wielding information tools for specific tasks is distributed throughout user departments. Some users, moreover, have developed especially high levels of technical knowledge which they apply to their own work and to assisting others. These are self-selected department experts, having become so at their own initiative. They act as trainers and technical consultants for others within their work groups. In addition, they are typically the ones most actively reinventing the technology, developing and sharing special programs and procedures for their own and others' work. (Whether such in-house expertise is the best way to enhance systems is discussed further in App. B, Issue #5).

All the users we interviewed agree that the integration of competent workers and powerful tools has enhanced performance at all levels of XYZ, and cited gains that they believed were measurable (even though no formal assessments were undertaken). For example, some vital procedures (e.g., commodity balancing) required nearly a day when done manually and now require one hour. Moreover, as one employee pointed out, no matter how carefully and slowly the manual work was done, it was more likely to contain errors than the computer-based equivalent. Still others cited operations they were unable to carry out before (e.g., modeling complex phenomena), or else did not do because they were too cumbersome to perform manually (e.g., testing multiple ingredient-formula interactions). Another mentioned doing work that would require three people without computer support. When asked about measurable performance gains, one employee summed up the general response to skeptics' questions about systems use and productivity by saying, "If they can't see the difference they're doing it wrong."

At the department level, measurable group performance gains were likewise reported. For example, one manager emphasized time-to-project-completion as an area of demonstrable improvement. Informally comparing time-lines and milestones for projects of similar scope undertaken in 1979 (pre-implementation) and today, he says that the same types of efforts can be completed much faster. Another key indicator is capability to respond to exogenous change. For example, using the online formula generator and experimental database, Product Development can rapidly alter its formulas and production plans to
accommodate to or take advantage of unexpected changes in price or availability of raw materials. Competing product manufacturers, in contrast, cannot respond as quickly and be assured of continued product consistency and quality—nor could XYZ, in the past.

Finally, organization level improvements are telling. In terms of bottom-line measures, XYZ has succeeded in cutting total costs per unit output, even though labor costs are higher. The firm has vastly increased the efficiency of its tools while retaining highly effective people. At the same time it is moving forward in market share. XYZ has achieved third-place rank and is closing in on second—it already surpasses the second-place competitor in product volume shipped and is not far behind in revenues. The most exciting organizational outcome, however, might be how well XYZ is positioned for "the information economy" of the 1990s. It has become a truism that in the new economy, information is part and parcel of a business's commodities and services—if so, having a command of information technology should be a strong competitive advantage. While this thesis is difficult to understand concretely, XYZ has begun to actualize it. The wedding of information technology to business strategy is potentially the strongest organizational performance gain.

EXPLAINING SUCCESS

Previous literature on organizational innovation has discussed many factors that promote successful technology transfer and utilization. Using the literature as a guide, we have identified characteristics within XYZ representing its major components—the organizational context, the technology, and the implementation process itself—that we think help to explain XYZ's successful effort.

Organizational Characteristics and Implementation Success

In most organizations, innovation is constrained by bureaucracy, work process, and job design; XYZ actively encouraged innovation. Three characteristics of XYZ demonstrate their commitment to innovation.

First, XYZ is people-oriented. One of its most important tenets is that success hinges on the fair and effective use of human resources. In practice, this means that it pays high salaries to attract top people and treats them well after they are hired. Egalitarianism prevails; there are no privileged classes—and no reserved parking spaces, private offices, or differential work schedule policies. Perhaps most
important is the understanding that people, not technology, drive performance. The firm views computers as tools needed by competent and motivated people to perform their jobs effectively.

Secondly, XYZ knows what it takes to motivate competent people. XYZ promotes individual and work group autonomy, encourages initiative, and rewards performance. One manager responded to the question, “How do you get people to be such self-starters, to be so innovative?” by replying, “They’re allowed to be. If you let them, people want to do a good job, they want to be effective, they want to learn new ways of doing things.” Other interviewees indicated that the organizational culture includes a strong emphasis on innovation, self-motivation, and the opportunity for individual employees and departments to take on responsibilities and redefine their jobs as needed. People who are not self-directed are unlikely to work for XYZ. Those who do say that initiative and performance are rewarded (e.g., compensation policy ties raises to improved volume and return on assets).

Thirdly, XYZ embodies a strong congruence between vision and action, between philosophy and practice. This becomes apparent when comparing XYZ’s philosophy with its personnel policies and practices (see Sec. III). The congruence was especially evident in relation to the concept of “Growth through information, communications, and experimentation.” Interviews with employees at all levels confirmed that this vision permeates XYZ and is manifest in the day-to-day activities of individual employees. Constant reference was made to the key role of information in effective decisionmaking and performance. Similarly, XYZ emphasizes the importance of open communications, particularly with respect to sharing ideas and alternative ways of doing tasks, and helping each other to learn and use computer-based tools. Experimentation—trying out new things—was also frequently mentioned by employees at all levels. In short, XYZ’s success owes partly to its practicing what it preaches.

Technology Characteristics and Implementation Success

Computer technology at XYZ does not consist of a single massive mechanism but of varied hardware and operating systems, numerous databases, and a multiplicity of software applications—both purchased and internally developed. As Kline and Scacchi (1983) insist, computer technology should probably be conceptualized more on the model of a web than a discrete entity. Given this complexity, it is difficult to single out characteristics of the technology that are probably related to successful implementation. However, empirical literature across domains of innovation provides a reasonable guide to such generic
properties. XYZ’s information system, we believe, strongly illustrates three second-order, generalizable characteristics.

First, the technology is mission-focused; substantive needs form the basis for computer system choices. This was evident both in the initial organizational impetus for investing in electronic technology and in the continued emphasis on technology-as-tool among users. In contrast, focusing on the properties of the technology per se, independently of their responsiveness to identified needs, typically produces implementation failures (Bikson, Gutek, and Mankin, 1981). There is some evidence of that difficulty prior to the implementation effort we studied. One employee, for example, said that before 1980 there was support for using a computer but “there were no goals, nobody knew where it was going, and we did it on a shoe-string budget.” Now, however, there is a clear picture of the role of information in XYZ’s business activities. As a high-level manager put it, “That’s why ‘business’ always comes before ‘systems’ in ‘business systems.’”

Second, the system is user-driven. While it is highly complex, its operations can be guided, modified, and manipulated by end users who had no prior experience with computer systems. Knowledge about how to exploit the system’s capabilities can be acquired in stages, as needed, so that the technology affords a powerful and flexible tool kit. Frequently, organizations opt instead for systems that are “idiot-proof”—easy to use, impossible to interfere with, and require little learning. Such systems, however, are typically “competency proof,” allowing little room for the exercise of users’ skills. The choice of user-driven technology permits XYZ to take joint advantage of the full potential of interactive systems and substantively knowledgeable users.

Third, the system is designed for change. XYZ’s policy in general is to provide its employees with state-of-the art tools, but the art in this instance is rapidly advancing. Consequently, the system has to be evolutionary, adaptable both to the emergence of new technology as it comes on the market and to extension and “reinvention” as users acquire greater expertise. Many organizations, in contrast, try to find the “right” system, install it, train to it, and never change it—whereupon changes become costly, difficult, and disruptive. For the foreseeable future, the XYZ system is in a development mode, not a maintenance mode.

Implementation Characteristics

The conceptual framework guiding this research (see Sec. II) provides evidence that the quality of an implementation process itself will
affect the quality of the results. For this reason we gave careful attention to describing XYZ’s implementation process (Sec. IV). Here we identify characteristics of that effort that contributed to its success.

First of all, XYZ began with a conscious implementation strategy. Most often, organizations introducing computer-based procedures give greatest attention to acquisition decisions and think very little about implementation. Implementation at XYZ had been carefully planned, staffed, and budgeted. As cost data reveal (Sec. IV), implementation expenses accounted for the greatest proportion of total information systems expenses (a not surprising fact, given the amount of person-time involved in determining information needs, locating and trying out appropriate applications, restructuring the work flow, and so on). By contrast, our larger field research study (Mankin, Bikson, and Gutek, 1985) found that most organizations do not know what they spend on implementation since it typically becomes an ad hoc firefighting effort not budgeted separately from the costs of hardware and software installation.

A second key feature is XYZ’s recognition that organizational innovation entails experimentation and risk-taking. Feedback sessions with employees established the experimental orientation as highly valuable in allowing user departments to try out new things and to get rid of tools that do not work out well. They emphasized, however, that trial-and-error learning about advanced technology requires nonnegligible budgetary commitments like other aspects of the implementation process. (In the earlier stages of system implementation, for example, XYZ guesses that it threw out about a fourth of its software acquisitions.) Nevertheless, as one senior-level actor argued, “diversity is a good investment.”

Creative tension between top-down and bottom-up system development is a third distinctive aspect of the implementation process we studied. This approach attempts to balance centralized and decentralized decisionmaking so as to reap the advantages of both. We use the term “tension” advisedly, since the two orientations emphasize contrasting goals: There is a drive toward centralized choices in order to evolve a system that serves the whole organization; and there is a drive toward user-based decisions since only they know what tools are needed. To avoid the tension created by such a dual orientation toward implementation, many organizations either opt for a unilateral approach (exclusively top-down or bottom-up) or else opt out (have technical experts do the deciding). XYZ instead attempts to unite top management support, technical expertise, and substantive user involvement. According to the CEO, maintaining a creative balanced tension (rather than destructive tension or one-sided imbalance) among these
forces in system development is the most difficult part of the implementation process.

Fourth, whether an implementation project has been generated by the top-down or bottom-up approach, it will likely be characterized by a great deal of user involvement. Participative decisionmaking, with users and user departments having a strong voice, has two significant concomitants. This practice promotes system "ownership" by employees, who thereupon have a strong sense of responsibility for it and a commitment to making it work. Equally important, perhaps, it is a practical way to link system design to substantive work needs.

A fifth implementation characteristic associated with its ongoing success, we believe, is adaptive training. Learning support is an eclectic mix that includes formal courses for commonly used applications, vendor courses on request, and peer training and technical assistance, informally supplied, by de facto experts on an as-needed basis; this process extends to take in very advanced learning. We underscore the importance of local long-term training resources adapted to specific user needs. Without them, it is difficult for individuals to move ahead on the learning curve and become capable of increasingly sophisticated deployment of the tools to which they have access. XYZ's approach is an example of how mid-size firms (without large in-house training departments and numbers of users at the same stage of learning) can provide training that will serve employees with widely varying needs and skill levels.

Sixth and finally, there is a characteristic that we call "organizational learning." As the account of the implementation process in Sec. IV makes clear, there is no "post-implementation" period. Rather, the information system continues to change and individuals keep finding new ways of working with it. New ways of working, in turn, generate needs for new system modifications or extensions, and so on. Instead of trying artificially to impose a steady state on the implementation process, XYZ is attempting to understand how innovation progresses. Rather than minimizing change, the organization has learned to manage it.

DISCUSSION

Our exploration of one organization's successful adoption of computer systems has led us to two broad conclusions:

- Information technology does not necessitate negative consequences for white-collar employees; on the contrary,
computer-based tools can enhance information work and enrich its performance.

- Neither the avoidance of negative change nor the promotion of positive change in work requires an organization to compromise its profit-making objective nor its endeavor to improve organization-level efficiency and effectiveness.

XYZ's experience, then, should help dispel the myth that technological advance cannot benefit both organizations and their employees.

We also believe that XYZ's experience illustrates alternative ways to think about computer systems in information-intensive settings. First, it is important not to equate the implementation of computer-based information systems with the "automation" of white-collar work—there is nothing necessarily mechanical or routinized about information-related jobs once they receive computer support. In fact, powerful interactive tools may demand greater skill, insight, creativity, and judgment from users at all levels of the organizational hierarchy. Second, it is misleading to think that these issues are about computers, as if the technology somehow determined its own application. Questions about the consequences of computer-mediated work should be understood as questions about management policy and choice.

The array of advanced information tools being virtually limitless, organizational actors are free to select and apply them in all sorts of ways. The characteristics of an installed computer system thus reflect the values of an organization—it can, for example, choose tools that expand the capabilities of competent workers. Work design and redesign in relation to computer technology are likewise expressions of management philosophy. Organizations can choose not to define new jobs or restructure old ones in dehumanizing ways. Most important, perhaps, it is possible to build features into the organizational innovation process that are likely to preclude negative outcomes and promote positive ones.

Whether the factors accounting for XYZ's success are generalizable to other settings is a debatable matter that further research into comparable cases might resolve. XYZ is in many respects unique, but its employees think their experiences are not. When we posed the question of generalizability to the head of its implementation team, he commented, "You know, five years ago I worked for a company that couldn't install anything and make it work—and it was XYZ." He therefore believes that XYZ's implementation strategy would yield similarly positive results for most organizations.

We suspect, too, that there is much to be learned from the XYZ example because it instantiates key elements of successful technological
change as cited in a growing body of empirical literature on organizational innovation (see Sec. II). However, the policy recommendations implicit in this example are primarily for organizational decisionmakers in the private and public sector who are responsible for technological innovation within their own settings. Additionally, market forces might provide an incentive for organizations to emulate positive practices—practices advantageous to themselves and to their employees—once they are made public. Finally, government policy might play a role by devising economic rewards or disincentives to encourage the mutually beneficial deployment of advanced technology.
Appendix A

THREE SAMPLE INTERVIEW PROTOCOLS

1. Interview Protocol for Users

OPENING REMARKS

1. Introduction:
   a. Exchange of names (confirm interviewee’s job title)
   b. Rand is studying the implementation of computer-based information and communication systems. We are exploring their impacts on individuals and organizations. Company XYZ was selected as a case study site because of the variety of ways its employees are using information technology.
   c. While Company XYZ as an organization agreed to participate in the research, individual interviews are entirely voluntary. Further, the interviewee should feel free not to respond to any particular question. Information in the final report will not be identified with specific individuals or organizations.

Do you have any questions? Should we go ahead?

2. Organizational location:
   a. Please summarize your job in this department.
   b. Explain that, in the main, questions are to be interpreted in relation to this specific department and job function. (There are no “right” or “wrong” answers—we want users’ impressions and experiences.)

3. Technology orientation:
   a. We are interested in how the department has incorporated advanced information technology into its work. When we ask about the computer system, we are referring to your workstation and the major applications you use.
   b. When we ask about changes in work and impacts on the department, we want to know what has happened relative to the user’s work since he/she first acquired the use of a multifunction interactive computer system.

4. Probes (for all topics):
   a. Expected (as well as actual) effects
   b. Differentiation of effects by sex, age, ethnicity, or job status
   c. Potential key actors not yet identified
IMPLEMENTATION
1. What was your department trying to accomplish in converting to online computer use?
   (If productivity, efficiency, or effectiveness is mentioned, probe for how it is defined or measured.)

2. What incentives, if any, are there for you in working online?

3. Process overview: Were you here when this department first got access to interactive computer systems for regular work? [If not, skip to TECHNOLOGY section]
   a. Describe how, if at all, users took part in decisions about matters of hardware; software; implementation processes; the work environment; effects on employees.
   b. Overall, how well did the change process work out?

TECHNOLOGY
1. When did you first start using a computer here?

2. Do you have your own workstation? (If not, how is it shared?)

3. Was this your first experience with computer use? (If not, note where else and for how long.)

4. What are the major applications that you use? What tasks do you use them for?

5. When you interact with the system, does the process unfold automatically, or do you guide the system?

6. Do you have any procedures for modifying the system (e.g., user-modifiable menus, user-definable keys, an end-user programming language)? If so, do you get a lot of use out of them? (Explain.)

7. Do you use computer-based mail? With whom do you mainly communicate? (Probe for informal as well as task-related communication.)

8. About how much time, in a typical day, do you spend working at a workstation? _____ (hours or % of total time). Is it continuous?

9. We're interested in any problems you may have with computer reliability or availability. For example,
   a. Can you easily get to use the equipment or software you need?
b. Is the response time slow/adequate/fast?
c. Does the equipment crash or have a long downtime?

10. Overall, from your perspective, what works well in the system? What doesn’t work well?

TRAINING

1. Now I’d like some information about training, from your viewpoint.
   a. Was learning to use the computer system voluntary for you and others in this department? (Probe: Does it differ for different users?)
   b. What’s the main goal of the training program, as you see it? (Probe for concrete operations vs. model-based understanding.)

2. After initial training, about how long did it take before you were up to speed on the computer and using it regularly for your work?

3. Can you describe any formal follow-up support for using the system (e.g., useful documentation, reference manuals, online help, whether error messages help the user correct his/her mistakes)?

4. What about informal support?

5. Long-term learning
   a. What are your opportunities for advanced learning and development? (Note whether employee has had any learning beyond initial training and whether he/she has pursued or will pursue it outside the firm.)
   b. Have you needed any additional training for new equipment or new software acquired by the department? (If so, how was it handled?)

6. Overall, how satisfactory is the support for learning in this department?

IMPACTS: INDIVIDUAL/GROUP

1. Now I’d like to ask you about any changes in your work—the activities, what you do—related to the system. (Probe for expansion vs. constriction, and for redistribution of work.)
   a. Changes in variety/variability?
   b. Changes in control over your work, especially in what is left to your own judgment?
   c. Do you have new tasks and responsibilities, or do you do the same job with a new tool?
   d. Have there been changes in job demands or workload?
   e. Changes in type of supervisory support? (Probe for machine pacing or monitoring of work.)
f. Have there been any management innovations as a result of the
technology (e.g., quality circles)?
g. Have you or other employees invented new ways of doing your
work as a result of the technology?

2. Have there been changes in communications, interactions,
relationships among people here because of the computer system
(describe)?
   a. Do users share new ways of doing things, e.g., "tricks" they’ve
discovered for getting around problems (probe for tool sharing)?
   b. Do computer-based communications replace memos, phone calls,
in-person discussion, range of contacts?
   c. Has the quality or frequency or nature of interpersonal interac-
tions in the office been in any way affected?

3. As of now, could you or other people in your department go back to
the old way of doing things?

4. Has the computer made a difference in the "productivity" of indi-
viduals in your department? (Probe for differences in quantity,
speed, quality, or other improvements in input, throughput, output.)

5. Has using a computer affected in any way the physical and psycho-
logical aspects of your job?
   a. Physical complaints? (Eyes/headaches; back/neck/shoulders?)
   b. Social issues? (Opportunities for interaction? Ade-
quate privacy?)
   c. Psychological responses (computer fear; attachment to former
workstyle; job insecurity; stress)

6. Has using a computer affected your job in official terms, e.g.,
new job title? New job description? Computer-related pay in-
crease? Other?

7. What has been the general impact of computer-mediated work on
the quality of working life for you? On your job satisfaction? On
your opportunities for advancement (here or elsewhere)? On your
satisfaction with the management?

CLOSING REMARKS
1. Having been through this experience, what advice would you give
to people who are just starting out?

2. What can organizations or government agencies do to ensure that
advanced information technology will have positive rather than
negative impacts on white collar work?
TERMINATION

a. Thanks for cooperating. May we phone if we have questions as we're thinking over this discussion?

b. We expect to hold feedback sessions when we have put together a preliminary report, sometime in January. We'll call to arrange an appointment.

c. The Rand study will be incorporated with other materials by the Office of Technology Assessment as a report to Congress in June. After that Report has been filed, Rand will publish and send to participants its research results.
2. Interview Protocol for Managers

OPENING REMARKS

1. Introduction:
   a. Exchange of names (confirm interviewee's job title)
   b. Rand is studying the implementation of computer-based information and communication systems. We are exploring their impacts on individuals and organizations. We selected Company XYZ as a case study site because of the variety of ways its employees use information technology.
   c. While XYZ as an organization agreed to participate in the research, individual interviews are entirely voluntary. Further, the interviewee should feel free not to respond to any particular question. Information in the final report will not be identified with specific individuals or organizations.

Do you have any questions? Should we go ahead?

2. Organizational location:
   a. Verify department’s position on the organizational chart.
   b. How many employees in this department?
   c. Would you summarize the department’s mission and your role.
   d. Explain that, in the main, questions are to be interpreted in relation to this specific department.

3. Technology orientation:
   a. We are interested in how the department has incorporated advanced information technology into its work. When we ask about the computer system, we mean the workstations in this department and the major applications in use by its employees.
   b. When we ask about changes in work or impacts on the organization, we’re referring to what has happened in this department since it first acquired the use of an interactive computer system.

4. Probes (for all topics):
   a. Expected (as well as actual) effects
   b. Differentiation of effects by sex, age, ethnicity, or job status
   c. Potential key actors not yet identified

IMPLEMENTATION

1. What were you trying to accomplish in converting to online computer use? (If productivity, efficiency, or effectiveness is mentioned, probe for how it is defined or measured.)

2. How does that relate to what’s going on in the organization?

3. When did this department go online? _____ _____ _____.
Tell me something about the process. When did planning for this change begin, and what was the general timing and pacing of the effort? How were events sequenced? What was the general approach? The focus?

4. Tell me how you went about implementing the technology. How detailed was the planning? Was the process flexible or experimental? Was there more concern with technical issues or with human issues?

5. We're interested in who had decisionmaking responsibilities in a number of domains. Considering the following groups of people—executive management, technical resource persons, human resource persons, department managers, and users—who made decisions about:

   Hardware:

   Software:

   Implementation process:

   Work environment issues:

   Employee impacts:

   (Note whether these actors were coordinated in the decision process and if so, how. Probe for balancing of varied inputs, and especially for participatory processes.)

6. What has been the employees’ reaction so far? (Probe for incentives.)

7. Overall, how well did the change process work out? When were the full effects of the conversion felt (or when do you anticipate them to occur)? How will you evaluate these outcomes?

TECHNOLOGY

1. What percent of employees in your department are computer users? ______.

2. What percent of employees have workstations? ______.

3. If not all users have workstations, how do you decide who gets them? (Probe for differences by sex, age, status.)

4. What percent of employees have telephones? ______.

5. How much of an increase has there been in workstations in this department since the first year? Do you expect further increases?
6. What kind of workstations do you have here?
7. What major applications (tasks) are they used for?
8. When you interact with the computer system does the process unfold automatically, or does the user guide the process?
9. What capabilities are there for user modification (e.g., user-modifiable menus, user-definable keys, an end-user programming language)?
10. Do you have computer-based mail? Who is on it so far? What percent of the employees use it? What do you use it for?
11. We're concerned to what extent certain issues were considered in designing the system.
   a. To what extent was the kind of work users do considered? (Probe for augmentation and automation, e.g., reducing labor costs.)
   b. To what extent was the information-flow or work-flow considered?
12. How reliable has the system been (crashes, downtime)? Can you estimate how much time your department loses as a result of system malfunction?

TRAINING
1. Tell me about the training conducted for the computer system. How long is initial user training in your department? How much was the department involved in designing the training?
2. After initial training, about how long does it take for an employee to use the computer as a regular work tool, or get up to speed on the system?
3. Is formal follow-up support provided? (Describe) (Note instances of useful documentation, reference manuals, online help, and whether error messages are clear enough to correct the user.)
   Describe any informal support.
4. Are there any opportunities for advanced learning? (Describe) (Note whether employees pursue training on their own, outside the firm.)
5. When new equipment or software is acquired how is retraining handled? (How often do they expect to have to retrain?)

6. In most workplaces a technology "expert" usually emerges. This is the person whom most people go to when they have a question or problem. Do you have an "expert"? What would you do (did you do) if he or she left? What kinds of problems would you anticipate (occurred)?

7. About what proportion of the operating budget does the department spend on training/staff development? Does the budget provide for follow-up or retraining?

8. Overall, how satisfied are you with learning support?

IMPACTS: INDIVIDUAL/GROUP

1. How has the work changed as a result of the technology implementation? (Probe for changes in work of managers, professionals, secretaries, other clerical employees.)
   a. Any changes in the way you organize the work (workflow/information flow)?
   b. Any changes in the hours of work or place of work? (Probe for home work and work contracted out—especially offshore.)

2. Have there been any management innovations as a result of the technology (e.g., quality circles)?

3. Have people invented new ways of doing their work as a result of the technology?

4. Does computer-based mail affect communications, such as memos, phone calls, in-person discussion, range of contacts? Explain.

5. As of now, could employees go back to the old way of doing things?

IMPACTS: GROUP/ORGANIZATION

1. Think about the changes in the department's work in relation to the organization. What changes have there been in work flow in/out of this group in relation to other departments?

2. Have there been any changes in management styles and procedures? (Probe for keeping track of performance by computer and for number of people they can supervise.)

3. Has planning or decisionmaking become more decentralized, or department centered, or has it become more centralized, from the top down?
4. Interviewer: Examine the Formal Job Changes Record that the Department Manager completed. See if it’s completed, and ask the following if applicable.

Did the level of compensation or benefits change for any of these employees?

What do you think will be the net effect of computerization on the size and composition of the staff in this department? In the organization? (Probe for differences in sex ratios or age distribution.)

If sizeable labor force shifts or reductions are anticipated, how will these be handled?

OUTCOMES
1. What changes have you seen over time in efficiency and effectiveness?
   (Efficiency usually means fewer people; effectiveness means doing a better job.) (Probe for changes in quality, speed, quantity, and so on.)

2. Have these performance changes made any difference in the performance of the total organization (e.g., productivity, other strategic goals)?

CLOSING REMARKS
1. Having been through this experience, what advice would you give to others who are just starting out?

2. Do you have any forum for discussing these issues within or outside the organization?

TERMINATION
a. Thanks for cooperating. May we phone if we have questions as we’re thinking over this discussion?

b. We expect to hold feedback sessions when we have put together a preliminary report, sometime in January. We’ll call to arrange an appointment.

c. The Rand study will be incorporated with other materials by the Office of Technology Assessment as a report to Congress in June. After that Report has been published, Rand will produce and send its research report to participants.
3. Interview Protocol for Technical Expert

OPENING REMARKS

1. Introduction:
   a. Exchange of names (confirm interviewee's job title)
   b. Rand, with sponsorship from the Congressional Office of Technology Assessment, is studying the implementation of computer-based information and communication systems. We are exploring their impacts on individuals and organizations. Company XYZ was selected as a case study site because of the variety of ways its employees are using information technology.
   c. While XYZ as an organization agreed to participate in the research, individual interviews are entirely voluntary. Further, the interviewee should feel free not to respond to any particular question. Information in the final report will not be identified with specific individuals or organizations.

Do you have any questions? Can we go ahead?

2. Organizational location:
   a. What is the technical department's mission and how is it involved with (local departments)?
   b. Explain that, insofar as possible, we'd like information that pertains generally to the four departments from the perspective of Technical support; exceptions, however, should be pointed out. (Check to make sure the Technical department has fairly similar relationships to all four.)

3. Technology orientation:
   a. We are interested in how information technology has been incorporated into white-collar work, using these departments as examples. When we ask about the computer system, we mean the equipment and software with which the users in these departments directly interact.
   b. When we ask about changes in work or impacts on the organization, we're referring to what has happened in these departments since they acquired the use of interactive computer systems, and what the general effect on the organization has been as a result.

4. Probes (for all topics):
   a. Expected (as well as actual) effects
   b. Differentiation of effects by sex, age, ethnicity, or job status
   c. Potential key actors not yet identified
IMPLEMENTATION

1. What were the organization's main objectives in converting to online computer use? (If productivity, efficiency, or effectiveness is mentioned, probe for how it is defined or measured.)

2. How do the missions of the focal departments fit into this overall picture?

3. Process overview: The first department went online in ________ . When did planning for this change begin, and what was the general timing and pacing of the effort? How were events sequenced? What was the general approach? The focus?

4. Can you describe the implementation strategy for these departments? Specifically, how detailed was the planning? Was the process flexible or experimental? Was there more concern for technical issues or for human issues?

5. We're interested in who had decisionmaking responsibilities in a number of domains. Considering the following groups of people—executive management, technical resource persons, human resource persons, department managers, and users—who made decisions about:

   Hardware:

   Software:

   Implementation process:

   Work environment issues:

   Employee impacts:

(Note whether these actors were coordinated in the decision process and if so, how. Probe for balancing of varied inputs, and especially for participatory processes.)

6. Overall, how well did the change process work out? Were the full effects of the conversion felt (or when do you anticipate them to occur)? How will you evaluate these outcomes?

TECHNOLOGY

1. What percent of your employees are computer-users? ________ .

2. What percent of employees have workstations? ________ .

3. If not all users have workstations, how do you decide who gets them? (Probe for differences by sex, age status.)
4. What percent of employees have telephones?

5. How much of an increase in workstations has there been in these departments since the first year? Do you expect further increases?

6. What kind of workstations do you have here?

7. Do terminals have local processing power (if applicable)? What kinds of processing units (mainframes, minis, micros, or multiples of these) drive the terminals (if applicable)?

8. What person/machine considerations were involved in workstation selection and configuration?

9. How many different hardware vendors are represented in these departments? Where does the software come from? Is the software customized?

10. What are the major applications in use? What tasks are they used for?

11. In general, when employees interact with the computer system, does the process unfold automatically, or do the users guide the process.

12. What capabilities are there for user modification (e.g., user-modifiable menus, user-definable keys, an end-user programming language)?

13. Is computer-based mail in use? Who communicates with whom and for what purposes?

14. We're concerned to what extent certain issues were considered in designing the system.
   a. To what extent was the kind of work users do considered? (Probe for augmentation and automation, e.g., to reduce labor costs.)
   b. To what extent was the information-flow or work-flow considered?

15. In designing a main system, a number of trade-offs are frequently faced. Did you consider any of the following issues? How did you resolve them?
   a. Easy-to-learn vs. easy-to-use
   b. Rigid, foolproof vs. flexible, powerful
   c. Off-the-shelf vs. customized
   d. System-driven vs. end-user-driven
   e. Automation vs. augmentation
16. Is the equipment reliable (crashes, downtime, slowness)? Can you estimate how much lost time costs the organization as a result of system malfunction?

17. Have you had any problems with system security (misuse of employee records, company data, client data, or private information)? Are there formal practices to protect data?

18. Overall assessment of system (what's working well, what's still missing).

TRAINING
1. General description of training, from the Technical Resources viewpoint.

2. After initial training, is formal follow-up support provided? (Describe)
   (Note instances of useful documentation, reference manuals, online help, hotline, and whether error messages are clear enough to correct the user.)

3. How does the organization view long-term learning?
   a. Are advanced learning opportunities currently available? (Note whether employees pursue training on their own, outside the firm.)
   b. When new equipment or software is acquired, how is retraining handled? How often do you expect to have to retrain?

4. In relation to the total cost of converting to interactive systems use, what sorts of proportions do the following represent (approximately):
   - Hardware ______
   - Software ______
   - Modifications ______
   - Implementation ______
   - Documentation and training support ______

IMPACTS: INDIVIDUAL/GROUP
1. How has the work changed as a result of the technology implementation? (e.g., managers, professionals do more keyboarding; secretaries have more tasks; new tasks are designed; new processes for doing the work are adopted.)

2. How fully are computer system capabilities being used in the four focal departments?
3. Have people invented new ways of doing their work as a result of the technology?

4. Have there been changes in communications and relationships between individuals or between departments? (Describe)?

5. Do computer-based communications replace memos, phone calls, in-person discussion? (Explain.)

6. Have computer-based communications created electronic "islands" as well as connections? Have they affected the work flow among departments or otherwise altered the coordination or structure of activities?

7. What is the expected pattern for future information technology diffusion? (Probe for large-scale integration efforts, and for plans to line the plant to the office.)

IMPACTS: GROUP/ORGANIZATION

1. Has there been (will there be) any move toward remote work, homework, or work contracted out (especially offshore)?

2. Has there been (will there be) a change toward measuring performance or pacing work by computer?

3. What are the net expected effects of computerization on the size and the skill mix of the organization? (Probe for whether they anticipate needing a larger inhouse technical staff.)

OUTCOMES

1. What has been the impact of information technology on:
   a. Productivity (how assessed)?
   b. Labor costs (how assessed)?
   c. On other efficiency goals (how assessed)?
   d. Do any of the focal departments figure predominantly in these effects?

2. What have been the impacts on other strategic organizational goals?

CLOSING REMARKS

1. Having been through this experience, what advice would you give to organizations that are just starting to acquire advanced information technology?

2. In your opinion, what is the most important technical question to be faced during the next 5–10 years?
3. Do you have a form for discussing these issues either within the organization or with peers outside the organization?

4. Is there a role for government policy relative to computer technology in white-collar work? (If so, where/what? If not, why not?)

TERMINATION

a. Thanks for cooperating. May we phone if we have questions as we're thinking over this discussion?

b. We expect to hold feedback sessions when we have put together a preliminary report, sometime in January. We'll call to arrange an appointment.

c. The Rand study will be incorporated with other materials by the Office of Technology Assessment as a report to Congress in June. After that Report has been filed, Rand will publish and send to participants its research results.
Appendix B

FOURTEEN EMERGING ISSUES

We provided evidence above that computer-mediated procedures in white-collar settings need not degrade work or deskill workers. In fact, focusing concern on such consequences may divert attention from other important issues as organizations make the transition to electronic information tools. Given that these are work-transforming new technologies, their use is likely to pose challenging and perhaps unanticipated issues that will require creative resolution.

In comparing the experience of work groups at XYZ, our research team was on the alert for such issues. We sought them within topic areas where employees in at least two work groups appeared to have divergent experiences or beliefs; the divergence was at least potentially conflictual in some respect; the outcome was not known; and different resolutions could differentially impact the individuals and groups involved.

To elicit clarification and comment, we expressed each issue as a question or speculation with bipolar outcomes arrayed on a five-point scale. These issue-scales were distributed to groups of research participants at the beginning of on-site feedback sessions for immediate completion (see issue-scales, Fig. B.1). Their responses were tallied while one researcher presented an overview of the case study and its major findings. Histograms displayed on transparencies with an overhead projector served to focus subsequent discussion about each issue (see sample, Fig. B.2). Three feedback sessions were conducted, one for executive management and two for other employees. In the executive session we did not collect completed response sheets; instead, the nine participants retained them and compared their own responses with those obtained in other sessions. Summary histograms in this Appendix present data collected from employees who signed up for non-executive feedback sessions (N=17). Where top management views on an issue appeared to differ from those of other participants, the divergence is described in the text that follows the histogram. Below we present each of the 14 issues along with a brief account of how it arose, a summary histogram representing session participants' initial responses, and a summary of the comments this feedback elicited.
1. A wide range of computer use—from NONUSER to TECHNO-PHILE—can create alternative user environments.

There will be room for all types 1 2 3 4 5 Two distinct, possibly antagonistic, groups will emerge (users vs. nonusers)

2. What should be managers' involvement?

Managers need hands-on knowledge of the system, or they don't know the business 1 2 3 4 5 Managers need to manage people, not data

3. Computers let users perform many of their tasks faster. This leads to:

Demands for more of the same work 1 2 3 4 5 Time for better, more creative work

4. Users spend varying amounts of time—sometimes a great deal of it—in technical activities

Job descriptions and levels should be revised to reflect them 1 2 3 4 5 Existing job levels and descriptions remain appropriate nevertheless

5. Users come to depend on special programs developed and shared by others. This practice:

Creates dangerous reliance on undocumented procedures 1 2 3 4 5 Is an innovative way to enhance computer systems

6. Computer users frequently experience eyestrain or back/neck discomfort.

Health and safety regulations should be developed 1 2 3 4 5 Government regulations in this area are undesirable

7. Computer system development should primarily be driven by:

User departments, who know what tools are needed 1 2 3 4 5 A centralized group with technical expertise

Fig. B.1—Emerging issues
8. When computer use isn’t an 8-hour-a-day activity, do you need as many workstations as users?

No—this is an unnecessary drain on equipment budgets 1 2 3 4 5
Yes—sharing equipment wastes more costly person-time

9. When a lot of work in an organization is done online:

Users acquire new insights into data and problem solving 1 2 3 4 5
Human judgment is ignored in favor of number-crunching

10. When a lot of work in an organization is done online:

Job ladders should remain much the same 1 2 3 4 5
Job ladders will inevitably change as a result

11. How is training best handled?

Users learn best through formal, sequenced instruction 1 2 3 4 5
Users learn best from their peers, on an as-needed basis

12. Should personnel departments have a key role in implementation?

Yes, in training and job (re)design, for example 1 2 3 4 5
No, technical or user departments can handle these things

13. Once you become an experienced user, it is clear that computer capabilities:

Have been dramatically overestimated 1 2 3 4 5
Are vast and have yet to be explored

14. The way computers have entered work at Company XYZ—

It probably couldn’t be done like this anywhere else 1 2 3 4 5
Most organizations could probably do the same thing

Fig. B.1—continued
Instructions to Participants

As organizations get beyond the first steps toward computer-based procedures in white-collar work, a variety of issues emerge. Below we have sketched a few of the issues raised in the course of this case study, along with some stances commonly taken toward them. Please circle the number that most closely reflects your view on each issue.
Issues

1. A wide range of computer use—from nonuser to technophile—can create alternative user environments.

At Company XYZ, as with other organizations, a variety of user types emerges. Non-users want nothing to do with computers. They may be afraid that they can't learn, have no interest in learning, or have legitimate reasons why their job does not require learning. Reluctant users learn because it's part of their job. Given a choice, however, they might not use the technology. Enthusiastic users have few technical skills to start, but they are excited about computers, are willing to learn, and possibly see computer skills as a way to job advancement. Finally, technophiles—who may also begin with few computer skills—embrace and experiment with the technology, and often become in-house experts.

The issue is whether this variety of user types can work in harmony in ways which promote, not impede, the work—or does variety necessarily create a have versus have-not atmosphere? How can organizations integrate these differences?

![Bar chart]

There will be room for all types

1 2 3 4 5

Number of responses

Two distinct, possibly antagonistic, groups will emerge (users vs. nonusers)

Associates acknowledged their worry, when the system was being introduced, about whether there would be an "A-Team and a B-Team" consisting of people with and without strong technical aptitudes. Their current view is that the critical skill is understanding how to bring information to bear on decisions. Whether needed data are obtained by directly interacting with the computer system or in some other way is much less important than knowing what information is needed and how to apply it. It was noted that high-skill users do tend to become "service departments" for nonusers who need computer-based informa-
tion; however, it was also noted that nonusers can bring a fresh view to how information can be organized and treated.

Top management respondents underscored the relationship between tools and job performance. If some jobs require computer technology, employees will have to be able to use it. Performance, then, was the touchstone along the user continuum.
2. What should be managers' involvement?

Whether and how information technology can change the traditional manager's role is an important issue. On the one hand, some users expressed concern that managers who do not acquire hands-on experience with systems lose control of their proper tasks. Some managers agreed, feeling disadvantaged by their lack of knowledge of the systems and applications their subordinates were using. On the other hand, users suspect that a manager who spends a great deal of time online may be neglecting his or her management duties.

The tool-using theme was emphasized in response to this issue. It was agreed that at Company XYZ managers are working units—it is expected that they have their hands on their work. The issue, then, is to what extent the working managers need to interact with the computer in order to know the business they are managing. It was emphasized that systems do not make decisions, people do; and the job of managers is to understand the decisions made by people in their departments and the kinds of information the decisions were based on. Consequently, managers may need to know the models, data structure, and logic of the information system relevant to the work of their departments. Whether they need to interact directly with the computer system for this purpose depends largely on the nature of the department's work.
3. Computers let users perform many of their tasks faster. This leads to:

As with many advances in work technology, computers make it possible for employees to perform their tasks in less time. The issue is what happens with the time that is saved? Are increased demands placed on users for more of the same work, or are they given the opportunity to be more innovative and to improve the quality of their work?

Participants unanimously agreed that computer-based procedures do save time, and that for the most part they use the time saved to improve their work. One group was careful to point out that, with manual procedures, time itself seriously limited the quality and creativity of information work—there simply was not enough time for more than fairly routine manipulation, analysis, and reporting of information.

Management respondents, however, acknowledged that faster, computer-based work could render a job boring, repetitive or unrewarding—an outcome that should be avoided by job redesign.
4. Users spend varying amounts of time—sometimes a great deal of it—in technical activities.

With the advent of computers, office users spend much more time in technical activities—maintaining databases, training others in computer use, and devising new applications. Does this mean that the user is now more skilled or that the nature of the job has changed? If so, should these changes be reflected in job descriptions and levels (and, by implication, pay or promotion)? Or is it more appropriate to view the job as essentially unchanged, with computer users performing the same functions as before but with different tools?

The dominant view on this issue was that job descriptions and levels should change but only if job content changes—and using electronic tools may change job content because tasks and tools reciprocally influence one another. For example, some jobs cannot be done without a computer (e.g., optimizing formulas over a set of criteria), and there are instances in which online work capabilities have changed the scope of employee responsibility (e.g., by providing the kind of information that enables a lower-level manager to make an on-the-spot decision that formerly could have been made at a higher level). In these kinds of cases, job descriptions or levels probably need changing. However, it was emphasized that time spent using the technology—like time spent on the telephone—is no indicator of whether someone is doing it wisely or well.
5. Users come to depend on special programs developed and shared by others. This practice:

With the emergence of in-house expertise and department-level "technophiles" comes the local development of special programs and procedures. The technophile may, for example, write an SAS program that does a particular analysis needed by several analysts in his or her department. This program is shared within the group. Because writing and sharing programs is not really part of the technophile's job, it is unlikely that time will be taken to document the program. Some departments rely heavily on their local experts. When asked what he would do if his expert left, one manager said he would go to the nearest bar. Although developing and sharing special programs and procedures is innovative, does it pay off in the long run? What good are undocumented programs if the expert is gone and problems are encountered? How can the organization protect its investment in user-generated applications?

![Bar graph showing responses]

Interestingly, top management seemed less concerned about this question than other respondents, who regarded the issue as more "thorny." Everyone agreed on the value of "home grown" software applications and special routines—and also that, because such programs are both relied on and undocumented, problems do arise when the innovator leaves the organization. Many respondents thought the situation was no different from what happens with manual procedures—where ways of structuring, manipulating, and storing information are also undocumented and where inheriting someone's file cabinet, for example, can be more of a burden than a benefit.

Some expressed the view that, when a "de facto" expert in some application domain leaves, others learn how to manipulate the system and readapter it to the task in new and possibly better ways. In
contrast, it was feared that those who remain might simply inherit a set of applications they do not understand, cannot modify, and cannot respond to in a problem-solving mode when things go wrong. Finally, it was agreed that some locally generated applications become vastly more important to the conduct of work than others—those should be identified and documented.
6. Computer users frequently experience eyestrain or back/neck discomfort.

Several people at XYZ voiced physical complaints, but few expressed a desire for external intervention—a view shared by others, as evidenced by the recent failure of a bill in the California State Legislature which was to provide worker protection regulations for computer users. In the absence of government regulations, what steps, if any, should be taken to assure health and safety? Who should have responsibility for employee protection in this area?

![Bar chart showing number of responses to a question about health and safety regulations.]

Everyone agreed that physiological discomforts are related to use of video display tubes. The issue seems to turn on who owns the problem and what should be done about it. Respondents do not believe it is government’s problem, and oppose federal or state intervention in the form of standards or regulations. They seem to believe that not enough is known about how to provide really good workstations in actual work environments, and that both vendor and user organizations are experimenting to find answers. De facto standards are expected to come from best practices as they emerge and are widely adopted.

Their view is that market forces will drive adoption of improved health and safety practices related to workstations in a number of ways. Vendors have a clear incentive to move ahead in this area, since whoever solves workstation problems first will have a strong competitive foothold among user companies who are concerned about their employees. Second, user companies who do not adopt improved practices will lose valuable employees to competitors who do. Bargaining units were not seen as having much potential leverage in this arena by employees, who thought white-collar unionization was either highly improbable or at best a very long way off. On the other hand, the threat of civil litigation from white-collar employees should provide a
strong impetus to eliminate negative workstation health and safety practices. Finally, some employees thought that, as a last resort, the government's role might be to help protect white collar workers through corporate economic sanctions or incentives.
7. Computer system development should primarily be driven by:

Some people argue that a centralized group with computer expertise (e.g., an information services or data processing department) should play the dominant role in systems development. This enables the standardization and integration of systems across an organization. On the other hand, users may know best what they need; they may not use effectively, if at all, a system they did not play a major role in developing. Therefore, a counterargument is that user departments should be the driving force in system development and implementation.

![Bar chart]

Participants emphasized users as the driving force in implementation, with the understanding that there is also necessarily an important role for centralized technical expertise. The issue, however, generated many comments and caveats. With respect to warnings, users pointed out that some parts of an information system should be centrally and uniformly maintained (e.g., customer billing should be, but decision support should not). Second, the importance of targeting an overarching system architecture as an organizational development goal was stressed. Third, users cited the need for dialogue between users and technical experts.

From the perspective of user-driven development, respondents urged organizations not to underestimate the payoffs of user commitment to the resulting system: Not only do they use it, but also they are always trying to find ways to make it work better. Next, they argued that the need for formal computer expertise in development had been overestimated. Current fourth-generation languages and other capabilities permit the motivated and task-competent user to do a great deal. The message, in no uncertain terms, was to "give users the benefit of the doubt for generating applications." Finally, top management
encouraged organizations not to be afraid of chaos, emphasizing experimentation as the key. They acknowledged that this strategy has costs, but it allows the organization to get rid of mistakes and to learn. As a by-product of top-down plus bottom-up development in this firm, the two initially opposed poles began to move closer together and to respect each other.
8. When computer use isn’t an 8-hour-a-day activity, do you need as many workstations as users?

This is basically a tradeoff issue between cost and access. Although most users are not online all the time, users who have to wait for system availability are less productive and often become frustrated. When an organization is paying top dollar for its employees, shouldn’t it provide them ample tools for doing their jobs?

Most respondents believed that XYZ needs more workstations, but that a 1:1 ratio is not necessary. Task queueing is the way that information workers have to organize their activities—whether the queue starts outside or inside the workstation. It was agreed that the nature of some jobs required workers to have more constant access to a VDT. One user, however, pointed out that access difficulties do not plague orderly task sequences that are going according to plan; more typically, they represent a sudden unanticipated question, problem, or bug for which immediate online “fire-fighting” is the only solution. The answer to the question “when do they need access” is always “now,” and waiting means prolonging a crisis.
9. When a lot of work in an organization is done online:

Computer technology provides the opportunity to access more information faster and to examine it with more sophistication than before. Does this availability promote better question-asking, or merely more question-asking and larger computations? Are intuition and judgment still important in decision-making, or do people become slaves to the data?

![Bar chart]

Participants said that number-crunching is not valued for its own sake at XYZ—it makes sense only if it serves some purpose. Again, they stressed the concept of the computer as tool, pointing out that numbers do not make decisions. On the other hand, the system is designed to make some of the easy, routine decisions so that humans can pay attention to the hard decisions. Some analysts described the value of number-crunching as “helping you better educate your educated guesses.”
10. When a lot of work in an organization is done online:

If computers change users' jobs in significant ways—to the extent that job levels and descriptions are changed, for example—will this affect career paths and job ladders? Are users likely to move into different kinds of jobs, having gained work-related computer experience?

![Bar chart showing number of responses]

While job descriptions may undergo substantial change as a reflection of the increasing importance of information technology in white-collar tasks, job ladders probably should change less. Again, the theme was that performance is rewarded, not tool-using per se. Further, employees noted that jobs on a career path are defined relative to one another. All are increasingly computer-based, and the whole path is moving apace. However, increasing experience with information tools may have opened new options; for example, individuals at the lower end of the job hierarchy are able to increase the scope and responsibility of their work (facilitating upward moves), and in some instances lateral mobility has been enhanced.
11. How is training best handled?

Training comes hand in hand with technology implementation. Whether training is handled formally, through sequenced instruction, or informally, from peers and do-it-yourself instruction, organizations must decide who should provide training and how much is needed. If a great deal of the training is handled informally, in an ad-hoc arrangement and by peers, should peer trainers be rewarded? Should some proportion of their work time be formally allocated to peer training?

The complexity of training as an organization becomes increasingly sophisticated with information tools was highlighted in all feedback sessions. Respondents valued formal instruction as an introduction to widely used applications, after which they believe it requires supplementation with peer training. Peer training is regarded at XYZ as an inherent part of the way user departments operate. While there are no extrinsic incentives for de facto teachers, both self-reward and the applause of colleagues were highly valued by these self-selected experts. Besides its flexibility, proximity, and task-appropriateness, peer training was found to build cohesion and reciprocity in work groups. However, it raises cost questions: How can departments afford to let valuable employees spend much time in one-to-one training, and how can these teachers find enough time to finish their own work? So the issue has two parts: how to provide the best learning, and how to give teachers a break. At XYZ these tradeoffs are informally worked out within departments, and costs ultimately force a balance between them.
12. Should personnel departments have a key role in implementation?

Introducing computers into white-collar work clearly brings up a number of issues that have traditionally fallen under the purview of human resource or personnel departments. These issues include the development of training programs and the possible impacts on job descriptions and levels as well as on career paths, employee job satisfaction, and the like. Given the significance and pervasiveness of these issues, shouldn't personnel departments play a key role in the introduction of computer-mediated work?

![Bar chart showing responses to the question of whether personnel departments should have a key role in implementation.]

Having heard participants' comments on issues involving training, job redesign, and career-path changes, it was no surprise to learn that they think personnel departments—given the way they currently operate—should not have key roles in implementation. Most respondents contended that personnel departments typically operate as rule-keepers and protectors of the status quo, and therefore should "stay out." However, there was agreement within top management that there is probably a need to reconsider the role of personnel departments in relation to the kinds of changes in work that can accompany the implementation of organizational information systems.
13. Once you become an experienced user, it is clear that computer capabilities:

Until employees gain sufficient experience with computers and see for themselves what computers can do, they may not be able to envision the full range of potential applications and uses. On the other hand, organizational expectations for computer systems have often proved unrealistic.

The overwhelming response from participants was that the capabilities of interactive organizational information systems are largely untapped. They point out that the potential for computer-based work has often been misestimated or misunderstood, and that they are just beginning to see what can really be done.
14. The way computers have entered work at Company XYZ—

Is there something unique about XYZ that would make it difficult or impossible to replicate their experience elsewhere? Or could other firms borrow from the XYZ model?

This issue generated a great deal of discussion in all sessions. The general consensus was that most organizations probably could do the same kinds of things, but that in fact most would not. Participants emphasized several properties of XYZ that promoted success. Several mentioned that the transition to computer-based procedures is easier in a young, medium-sized organization—where there is less red tape and less protected turf. Others argued it could not have succeeded had it not been built on a policy of high skill and high pay. Most cited elements of the implementation strategy. For example, at XYZ the system came in as a response to a serious economic problem: Its operations rely heavily on information work, manual procedures are slow and cumbersome, and new technology held the potential for turning the business around. Moreover, they had confidence in computer-based information systems and really believed in them as problem-solving tools. Further, the technology transition was voluntary, not forced, for users. Finally, the willingness to experiment, to do things differently, was stressed: "You have to be able to change" was the bottom line.
Appendix C

FOUR VIGNETTES ILLUSTRATING
INFORMATION WORK AT COMPANY XYZ

MARKET RESEARCH

The Brands Department at XYZ learns that a competitor has a new product in the market. It asks a market research analyst to determine how well the product is doing in market shares, to profile consumer buying behavior (e.g., number of people who tried the product, number of people who used the product again), and to forecast the product's long-term market share potential.

The analyst's first task is to determine which databases (online or hardcopy) contain the relevant information. In this case, he chooses Prompt, an online market fact book which organizes all items found in grocery stores into 8 market areas. It tracks buying information for each of 2500 consumers (called panelists) in each of 10 stores in each market area.

A number of options for analyses are available: trial and repeat analysis (assesses potential market shares for a new product); brand shifting (assesses the number of people who switch brands within a category or leave the category altogether); source of volume (assesses brand shifting for new brands); market summary (assesses key measures of the state of business, such as number of buyers, frequency of purchase, whether the sale was negotiated by cash, coupon, or display, and market share); and demographic analysis of panelists.

In this case, the analyst chooses the trial and repeat analysis; the computer requests him to specify analysis parameters such as time frame, category, market, and specific items. Further queries allow the analyst to determine analysis turnaround times (e.g., immediately, overnight) and their associated costs.

The trial and repeat analysis also has a model-building option for forecasting future market shares for the product in question. The analyst uses this option to test several models, based on hypotheses he makes by examining output from the initial analysis, data from other sources (e.g., an online database on grocery warehouse sales), or knowledge about sales of similar product lines. Other databases are also queried to provide additional information for understanding certain events. For example, if the modeling suggests that sales are down,
other sources may indicate that delayed product distribution was at fault—they simply ran out of the product at the store.

When the investigation is complete, the analyst uses the text processor to prepare a summary report of his findings. A typical report is 3 or 4 pages of text, with 5 pages of accompanying data tables and graphs. The report becomes the body of a memo with his recommendations to the Brands Department.

**PRODUCT DEVELOPMENT (R&D)**

The Commercial Department at XYZ learns of the availability of a new raw material that may be appropriate for use in one of their product formulas. It sends an inquiry to the Product Development Supervisor for that product line in R&D: What would be the value of that material from the formula development standpoint?

The Product Supervisor accesses the firm's raw materials database, which includes information about products, ingredients, costs, and the like. By hand, she enters an imaginary product profile, one that has the proposed new material in its formula in place of the current ingredient—making whatever adjustments this will require among other ingredients in the old formula. Using the customized database that contains knowledge about ingredients and their properties, she first checks to make sure that the proposed ingredient does not generate undesirable interaction effects when combined with other ingredients in the proposed formula. She then overrides an existing cost parameter, putting in a value that represents a likely price for the new ingredient. At this point she executes the linear program over the hypothetical new product formula, optimizing on cost. If the results look comparable to costs for the present product formula, she will probably rerun the optimization program using other assumed price levels (some higher and some lower than the expected value), to establish a range of prices over which the available new material looks like a good buy.

On the basis of these inquiries, the product development supervisor will make a recommendation to the Commercial Department. She might, for example, conclude that from the product development standpoint the new material looks very valuable if the price is at or below a given level, and if it can be purchased in sufficient quantity to meet at least 15 percent of the firm's need for a particular ingredient in the next quarter's production. If either of these conditions cannot be met, she would recommend against the purchase. Within hours, the Commercial Department will be able to respond to the raw materials market.
FINANCIAL CONTROL

Every four weeks, thirteen times a year, the Controllers’ Office “closes” the books. This requires the General Accounting Department at each plant site to enter expenses and revenues for the preceding four-week period into the General Ledger (GL) System. All of this information is integrated into an overall profit and loss (P & L) statement for the entire company. The Cost and Budget Supervisor then reviews the P & L statement for the period, comparing it with forecasts provided by the Planning Department. If there is a significant variance between actuals and forecast, he reviews several more detailed, subsidiary statements on the GL system to track down its source. These subsidiary statements provide information on sales revenues and advertising and promotion costs for each product the company produces, and manufacturing costs (materials, labor, overhead) for each site. He examines estimated and actual costs for each of these items to find the source of the original variance. He also talks to appropriate people in the site accounting offices for background information on the source and nature of variances.

With regard to the nature of the variation, three outcomes are possible:

1. Some variance is due to accounting errors. If so, the errors are corrected.
2. Variance may be partially due to timing, i.e., costs or revenues forecast for a later period occur during the present period. If so, compensatory variances should show up in a later period. The supervisor notes to himself to look for these variances in later periods.
3. The variance may be true, i.e., due neither to errors or to unexpected timing. If there is true variance, then an analysis is made to determine whether it is trend-related (repeating) or a one-time problem. True variances are reported to the V.P. of Service and Finance, who decides what steps to take.

Assume, for example, that on the GL system at period closing, the supervisor finds $0.5 million over forecast in the P & L statement for promotions. He calls up promotions expense reports for each product on the system and learns that all of the variance is due to one product. He further examines the GL entries for that product to see what has been charged under promotions expense. He finds that coupon redemption for that product during the period is $1 million when only $0.5 million had been forecast by Planning. He isolates one coupon in particular as the source of the variance. He examines the history of
the coupon to determine if the variance is trend-related or a one-time occurrence. Since the two preceding periods have also seen unfavorable variances for that coupon, although not as high as at the present level, he decides that the variance is trend-related and will probably continue. He presents the information to the V.P. for Service and Finance for further action.

PLANNING

Once a month, the Sales and Distribution Planning supervisor prepares a detailed sales forecast of every product made. He forecasts sales and distribution of every brand size (13 sizes) by geographic level (7 levels) and by period (4 weeks) over an 18-month period. Forecasts are used to determine plant needs (such as how much of a product to produce and where to inventory it).

The first step in the process is to compare last-period forecasts with the actual values for that period. The "actuals" come from the Decision Support System (DCS), which runs on the main IBM computer. The data are downloaded to the Prime computer for use in the EXPRESS system. The supervisor uses the Sales Forecasting System (SFS) to compare the previous forecast (also online) with the actuals. (The SFS is a customized software application originally developed by outside consultants in conjunction with members of the Planning Department). The supervisor chooses, from a set of options, the programs he will use to complete this analysis. Since the report program is executed overnight, results are usually ready the next day. One report is generated for every brand size.

Next, the analyst searches for where and why some forecasts and actuals do not match. A sales promotion, for example, may cause actual sales to outnumber projected sales in one region. This analysis of the discrepancies between forecasts and actuals provides information for adjusting future projections. For example, if a promotion increased sales and the promotion is scheduled to continue for six weeks, the next period’s forecast must be adjusted to account for greater-than-anticipated consumer purchases.

The analyst may also make other changes before preparing the next forecast. For example, since marketing activities drive sales, he would incorporate any changes in those activities in sales estimates.
REFERENCES


