Understanding the Implementation of Office Technology

Tora K. Bikson

June 1987
The research described in this report was sponsored by the National Science Foundation.

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A RAND NOTE

N-2619-NSF

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Prepared for
The National Science Foundation
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The RAND Corporation

ABSTRACT

What leads to the successful introduction of new office technology in an organization? This question was addressed in a survey of 55 work groups using advanced office technology in 26 organizations. Success includes the extent to which the technology is used, the users' satisfaction with it and with the jobs they perform using it, and improvements in organizational performance. Features of the organization itself, features of the technology, and the process by which the technology is introduced into the organization all play a role. For example, work groups in which computerized jobs retain variety, in which workers have exclusive use of a workstation, have electronic mail, and functional software, and in which the implementation used a balanced social and technical approach and encouraged worker participation in the introduction process all had more successful implementations. The chapter concludes with observations about areas where technology, implementation process, and research all need improvement.

The 1980s have witnessed the widespread introduction of computer-based tools into white-collar work, and the forecast is that this rain of new technologies will continue for the remainder of the century. For this reason, we undertook a field research project aimed at exploring how computerized procedures are incorporated in information intensive environments. The study was supported by the National Science Foundation (see Bikson, Gutek, & Mankin, 1985) as part of its general interest in technology transfer—how are innovations successfully transferred from contexts of development to contexts of application?

We approach the understanding of innovative office technology from this standpoint, treating implementation as a proper instance of "the translation of any tool or technique, process or method of doing, from knowledge to practice" (Tornatzky et al., 1983; cf. Bikson, Quint, & Johnson, 1984). Given that organizations will be deluged with electronic information tools in the years to come, it would be very helpful to find out whether there is something generalizable to be learned about the transfer and utilization of these new work-transforming technologies.

CONCEPTUAL FRAMEWORK

For this purpose, we relied on a conceptual framework that has proved relatively robust in recent research on the implementation of organizational innovations across varied domains (see Berman & McLaughlin, 1978; Bikson, 1980; Eveland & Rogers, 1980; Tornatzky, Fergus, Avellar, Fairweather, & Fleischer, 1980; Yin, Quick, Bateman, & Marks, 1978; and the detailed review in Bikson, Gutek, & Mankin, 1981). A review of that literature led us to three classes of hypothesized influences on the successful implementation of office technology.

- Characteristics of the organizational setting—of offices, in this instance—were expected to influence the results. Here we defined offices as organized behavior settings comprising at least four persons, at two or more occupational levels, jointly involved with some information-based process or product. This definition is congruent with conceptions of work groups or primary work subsystems employed in traditional organizational research.

- Features of the information technology were likewise expected to affect implementation success. For research purposes we specified the technology of interest as multifunction interactive computer systems deployed to support white-collar work in offices as previously defined above. We did not target specific hardware configurations, system architectures or software applications.

- Third, we explored implementation strategies—the sequence of activities undertaken in the effort to embed new technologies in extant organizational settings. Ranging from initial planning and decision-making to post-installation modification and training, properties of the implementation process itself were expected to exert the strongest influence.

These potential sources of effect were regarded as closely interrelated and situation dependent. Although they can be separately considered for heuristic purposes, they are likely to be reciprocally influential in fact.
The last element required for the conceptual framework—a viable idea of implementation success—was the most problematic. No consensual criteria were available either in research studies of organizational innovation or in more specific literature on office performance. The difficulty was compounded by the fact that we needed criteria applicable across quite varied office settings. We therefore adopted a broad approach to the construct of successful implementation, representing it in a number of ways.

We treated system use, first of all, as at least a necessary condition for success; thus we examined, for example, the ratio of actual to potential users as well as the proportion of potential users who expected to be interacting with the computer system in the near future. We also took user satisfaction (e.g., perceived "friendliness" of the computer system, overall satisfaction with the new technology, and general job satisfaction) as a face-valid indicator of success. Finally we considered a set of performance effects, including user assessments of productivity as well as manager-rated productivity improvements and value-added gains. Together these variables provided a multifaceted representation of implementation success.

PARTICIPANTS AND RESEARCH PROCEDURES

Private sector organizations that had introduced multifunction interactive computer systems as work tools in white-collar departments at least 6 months prior to the start of the research were sought for participation. Table 9.1 describes the sample we recruited (see also Bikson & Gutek, 1983a). It should be noted that in most organizations, advanced office technology is not evenly distributed; rather, some departments have come to think of it as a way of life, whereas others have only just heard of it. The departments participating in this study are early adopters of information technology; thus they do not necessarily represent all white-collar work groups. However, because the sample is otherwise extremely varied (e.g., in mission, hierarchical status, industrial sector), we believe the implementation lessons it presents may be generally instructive.

<table>
<thead>
<tr>
<th>TABLE 9.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Sample</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>26 Organizations</td>
</tr>
<tr>
<td>- 50% manufacturing</td>
</tr>
<tr>
<td>- 50% service</td>
</tr>
<tr>
<td>55 Work Groups</td>
</tr>
<tr>
<td>- range: 4–40 employees per group</td>
</tr>
<tr>
<td>- mean size: 10 employees per group</td>
</tr>
<tr>
<td>530 Employees</td>
</tr>
</tbody>
</table>
Because we sought comprehensive information in a number of domains, we used multiple instruments and data sources. Information-gathering methods included standardized surveys to all members of participating work groups and structured interviews with the department heads; in addition, we collected archival information about the computer systems in use and related budgeting and staffing patterns. A year later we made follow-up research visits to a balanced subsample of about half the participating sites (see Bikson, Gutek, & Flankin, 1985, for a complete description of the procedures). The discussion that follows is based on the first round of research visits to the full sample, although in many instances what we learned during the follow-up stage of the study assisted us in interpreting the findings.

The definition of *office* just given requires that work-group members be organized in relation to information-related processes or products. After data collection we first attempted an a priori categorization of work groups according to their organizational missions. We found that, although the groups varied broadly in respect to task domains, they seemed to be classifiable into four work-group types based on the information-related function they performed. Table 9.2 shows the distribution of participating work groups among the four categories (these are roughly comparable with Chamat's, this volume, three groups, except we have split professional offices into two categories).

The upper management and administration groups in this classification are typically fairly high in organizational hierarchies and have decision-making, planning, and oversight responsibilities. They include, for example, corporate strategic planning offices and fiscal comptrollers' offices. We distinguished two types of groups that carry out professional functions. The "text-oriented" professional offices were so designated because their major products tend to be text-bearing documents (either print or electronic). Examples are legal offices and public relations offices. In contrast, the "technical" professionals tend to have products that take the form of specifications, designs, formulas, and the like. In this category, for instance, are electronic design departments and internal Research and Development (R&D) departments. The fourth group comprises offices that provide support services and tend to be located nearer the bottom of the organizational hierarchy. Reservations and bookings offices, inventory control, and accounting offices are examples in this category.

**TABLE 9.2**

<table>
<thead>
<tr>
<th>Work-Group Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>24% management, administration</td>
</tr>
<tr>
<td>29% professional (text orientation)</td>
</tr>
<tr>
<td>20% professional (technical orientation)</td>
</tr>
<tr>
<td>27% secretarial, clerical, technical support</td>
</tr>
</tbody>
</table>
We underscore the importance of the work-group level of analysis for attempting to understand the transition to computer-based information tools. First, organizations are actually structured this way, allocating functions to subunits; work-group membership (as the previous examples suggest) has at least as much influence as occupational level on tasks performed (Bikson & Gutek, 1983a). Second, sound decisions about what hardware and software tools are needed cannot be made apart from understanding the type of work unit in which they will be used (Bair, this volume). Finally it is at the work-group level that implementation processes are typically carried out—it provides an appropriate way of chunking the transition.

REPRESENTING IMPLEMENTATION SUCCESS

The theme of good tools for information work broadly expresses the implementation goal for organizations taking part in this study, although they differed in many specific respects. For example, interview responses established that in half the groups new computer technology was viewed primarily as a tool for upper management and professionals; in another third, its usefulness to managers, professionals, and support staff equally was emphasized; and in 17% of groups it was regarded chiefly as a support staff tool. Given the diversity of technology aims and work-group missions represented in the research, we explored many general indicators of implementation success along the dimensions of use, satisfaction, and performance.

Members of participating work groups were all surveyed, whether or not they were computer users. We took as a prima facie index of implementation success the proportion of employees in each who interacted directly with a computer system in some way during their work. Those not currently using a computer were asked whether they expected to within the next year or so. Table 9.3 presents the proportion of current users, future users, and committed nonusers within occupational level. Although the dependent measure used for analysis purposes is proportion of computer users within a work group,

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Currently use a computer</th>
<th>Expect to use a computer</th>
<th>Do not expect to use a computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive</td>
<td>36%</td>
<td>46%</td>
<td>18%</td>
</tr>
<tr>
<td>Managerial</td>
<td>71%</td>
<td>26%</td>
<td>3%</td>
</tr>
<tr>
<td>Professional</td>
<td>70%</td>
<td>18%</td>
<td>3%</td>
</tr>
<tr>
<td>Technical</td>
<td>81%</td>
<td>18%</td>
<td>1%</td>
</tr>
<tr>
<td>Secretarial</td>
<td>64%</td>
<td>23%</td>
<td>13%</td>
</tr>
<tr>
<td>Clerical</td>
<td>73%</td>
<td>21%</td>
<td>6%</td>
</tr>
</tbody>
</table>
their breakdown within job category is instructive. It appears there is not much support for the view that managers will not keyboard, and the majority of executives in this sample expect to be using a computer in the near future. On the other hand, it is executives and secretaries who are disproportionately represented among the committed nonusers.

In addition to percent of users in a group, we constructed two more use-related variables. System acceptance is an ordinal variable with a value of 0 for subjects who say they will never use a computer and a value of 3 for current users; those who expected to learn within the next few months or years received intermediate values. System incorporation, another ordinal variable, is based on users' answers to a question about the extent to which computer-based tasks had become a regular part of their work repertoires; their responses ranged from 1 to 3, while nonusers were assigned a value of 0. Work-group means served as dependent measures in subsequent analyses involving these variables.

In addition to employee use measures, we also explored employee satisfaction measures. Both popular media and trade journals had advanced the view that technology interfaces are so ungraceful and cumbersome (if not frightening) as to seriously impede casual users (Bikson & Eveland, 1985). To explore potential negative effects of interactive tools on users' task experiences, we asked work-group members to rate their level of satisfaction with the "friendliness" of their computer system in particular and with the new office technology in general. Table 9.4 presents their responses. (Job satisfaction data, not tabled here, were obtained by summing responses to two standardized survey items from the University of Michigan's organizational assessment package. Outcomes were similar but more positively skewed and exhibited less variance.)

Examining the data in Table 9.4 suggests that employees in our sample, on the whole, find the electronic information tools introduced into their work settings relatively satisfactory. Although we observed little in the way of differences between work-group types on these and other satisfaction meas-

<table>
<thead>
<tr>
<th>TABLE 9.4</th>
<th>Satisfaction Reports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Satisfied</td>
</tr>
<tr>
<td>Computer system friendliness</td>
<td>40%</td>
</tr>
<tr>
<td>New office technology</td>
<td>38%</td>
</tr>
</tbody>
</table>
features we explored (Bikson & Gutek, 1983a), there are two exceptions. First, technical professionals—those with greatest expertise—are least satisfied with the friendliness of their computer systems. Second, text-oriented professionals are happier with the new office technology than are other types of groups.

Work-group performance effects constituted the third sort of success indicator we investigated. In Table 9.5 a set of productivity-related outcomes are summarized, based on data obtained from heads of participating work groups. When productivity is defined in terms of increased output by the work group, substantial improvements are cited. On the other hand, in terms of decreased labor costs, over half the groups report no change.

Examining the staffing impacts of computerization by job level helps explain why. It is only at the secretarial/clerical level that sizeable staff reductions have occurred, but these positions are least costly to retain. In contrast, managerial positions have remained relatively stable and professional staffs have grown. In general, outcome measures suggest some changes in work performance but do not provide evidence of dramatic overall improvements (see also Bikson, Gutek, & Mankin, 1985).

Effects of computer-based tools on office costs and outputs are displayed here because they represent the most frequently cited objectives for introducing the new technology. To create a dependent variable representing successful implementation across work groups, we combined cost and output reports from managers. The resulting three-level productivity improvement indicator receives a value of 1 for groups who report no positive change relative to their objective (either cost reduction or output increase) and a value of 3 to those who report substantial positive change; intermediate gains receive the

<table>
<thead>
<tr>
<th>Output</th>
<th>Percent of Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>No increase</td>
<td>13%</td>
</tr>
<tr>
<td>Some increase</td>
<td>47%</td>
</tr>
<tr>
<td>Substantial increase</td>
<td>40%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Labor Cost:</th>
<th>Percent of Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>No decrease</td>
<td>51%</td>
</tr>
<tr>
<td>Some decrease</td>
<td>34%</td>
</tr>
<tr>
<td>Substantial decrease</td>
<td>15%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Staffing Impacts by Job Level:</th>
<th>Percent of Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less</td>
<td>No Change</td>
</tr>
<tr>
<td>Secretarial/clerical staff</td>
<td>36%</td>
</tr>
<tr>
<td>Professional staff</td>
<td>7%</td>
</tr>
<tr>
<td>Managerial staff</td>
<td>6%</td>
</tr>
</tbody>
</table>

TABLE 9.5
Reported Work Group Performance Effects
intermediate value. Managerial interviews also probed potential value-added effects not captured by productivity indicators (such as improved accuracy in planning or forecasting, more timely completion of information intensive projects, and the like). To explore such outcomes, we created a three-level dependent variable representing managers' assessments of value-added benefits achieved. Finally, from users' self-reports of the impact of the computer on the quantity, speed, type, and quality of their work plus the quality of their work experience we constructed a summary index of individual performance effects; a continuous variable, its values were generated by factor scoring procedures. (See Bikson, Gutek, & Mankin, 1985, for more information about dependent measure construction.)

EXPLORING INFLUENCES ON IMPLEMENTATION OUTCOMES

Within the three broad outcome categories—use, satisfaction, and performance—we explored a number of ways of representing implementation success. As the preceding section describes, we devised three variables within each category for a total of nine dependent outcome measures. Adhering to the proposed conceptual framework, we next explored each of the hypothesized sources of influence (characteristics of the organizational context, the computer system, and the implementation process itself) to see how they might be related to implementation success.

For this purpose we carried out a number of univariate analyses, looking at relationships between outcome measures and each of the many potential explanatory variables suggested by the conceptual framework. Our aim was to find subsets of variables in each hypothesized component of the framework that (a) have a conceptual basis in previous innovation research; (b) are not confounded with group type; and (c) have predictive relationships to multiple measures of implementation success. Variables that met these criteria within each hypothetical component of the implementation framework were combined and treated as predictors in multiple regression analyses, with each implementation success measure serving as a dependent variable.

All these analyses were carried out at the work group level (number of cases = 55), with individual survey responses aggregated and linked to interview and archival data. Results are reported as significant if the probability value associated with the statistical test employed is .05 or less; obtained probabilities of about .10 or less are termed marginally significant. Findings from these analyses are summarized later (for a more complete account, see Bikson, Gutek, & Mankin, 1985).

All three classes of theoretical influence evidenced some significant relationships to the success measures we studied. For brevity the following discussion focuses on the predictors within each class of influence that had
greatest statistical effect across the dependent measures. Findings should be interpreted as indicating systematic associations that are not necessarily causal in nature.

ORGANIZATIONAL CONTEXTS AND IMPLEMENTATION SUCCESS

In order to learn what kinds of activities characterize information-intensive settings and whether they are differentiated by group type, we asked survey respondents whether they performed each of 18 different tasks as a regular part of their work. The task list represents activities that occur frequently in white-collar work and that can be done with or without a computer. Using a factor analysis (see Bikson & Gutek, 1983a, for a more complete description of this procedure) we identified four sets of co-occurring tasks that account for about 60% of the variation in activities performed. The groupings in Table 9.6 show obtained task sets (i.e., tasks that are, on a statistical basis, likely to co-occur). We then assigned scores to individual employees representing the extent of their involvement with the activities in each set.

Task sets strongly differentiated individuals employed in the four different types of work groups. Analyses of variance treating group type as the

<table>
<thead>
<tr>
<th>TABLE 9.6</th>
<th>Information Handling Activities Co-occurring Task Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor II</strong></td>
<td>Edit and rewrite</td>
</tr>
<tr>
<td></td>
<td>Proofread and correct</td>
</tr>
<tr>
<td></td>
<td>Write original material</td>
</tr>
<tr>
<td><strong>Factor I</strong></td>
<td>Maintain files</td>
</tr>
<tr>
<td></td>
<td>Process records</td>
</tr>
<tr>
<td></td>
<td>Fill in forms</td>
</tr>
<tr>
<td></td>
<td>Handle messages</td>
</tr>
<tr>
<td></td>
<td>Keep activity logs</td>
</tr>
<tr>
<td></td>
<td>Maintain inventory</td>
</tr>
<tr>
<td></td>
<td>Keyboard text or data</td>
</tr>
<tr>
<td><strong>Factor III</strong></td>
<td>Fiscal operations</td>
</tr>
<tr>
<td></td>
<td>Statistical computation</td>
</tr>
<tr>
<td></td>
<td>Distribute information</td>
</tr>
<tr>
<td></td>
<td>Maintain a database</td>
</tr>
<tr>
<td></td>
<td>Develop forms</td>
</tr>
<tr>
<td></td>
<td>Communication</td>
</tr>
<tr>
<td></td>
<td>Administrative support</td>
</tr>
<tr>
<td><strong>Factor IV</strong></td>
<td>Programming</td>
</tr>
<tr>
<td></td>
<td>Maintain a database</td>
</tr>
<tr>
<td></td>
<td>Statistical computation</td>
</tr>
<tr>
<td></td>
<td>NO communication</td>
</tr>
</tbody>
</table>
independent variable and factor scores as dependent measures (Bikson & Gutek, 1983a) yielded the following results. Activities in the first group, primarily involving the management of information, are distinctive of individuals employed in support groups. In contrast, individuals in text-oriented professional groups more often perform the writing, editing, and proofing activities in Group II, whereas technical professionals are distinguished by their engagement with the more computational, statistical, and numeric tasks in Group IV. Finally, higher level management and administration employees are differentiated by the information-handling activities in Group III. Interestingly, verbal communication was strongly and positively associated with management tasks but strongly and negatively associated with technical tasks.

We regard these findings as corroboration of our original classification of offices into group types based on organizational function. Although we were not surprised to learn that different types of groups tend to do different sets of activities, we were surprised to learn how many activities are performed in common by white-collar employees, regardless of the type of office. Table 9.7 shows the most widespread information-handling tasks along with the percent of survey respondents who do each in the course of their regular work. Other chapters in this volume (Bair, Bjørn-Anderson, Chamat) suggest some of the reasons for this finding—support staff are performing more professional functions and professional people are handling more of their own support needs. Almost everyone has to communicate either verbally or by text, and most people have some sort of information files to maintain. Looking only at the sum of tasks performed, we found that management and administration employees engage in the greatest number of different activities and support staff, the least. It would seem that work groups differ more in the variety than in the specific type of information-handling function performed.

Moreover, all the work groups appeared to be engaged in tasks that could be assisted by interactive information tools. We then explored a variety of

<table>
<thead>
<tr>
<th>TABLE 9.7</th>
<th>Information Handling Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Most Common Tasks</strong></td>
<td><strong>Percent who do each</strong></td>
</tr>
<tr>
<td>Communicate verbally</td>
<td>96%</td>
</tr>
<tr>
<td>Write original material</td>
<td>66%</td>
</tr>
<tr>
<td>Proofread and correct</td>
<td>63%</td>
</tr>
<tr>
<td>Edit and rewrite</td>
<td>57%</td>
</tr>
<tr>
<td>Maintain files</td>
<td>57%</td>
</tr>
<tr>
<td>Handle messages</td>
<td>49%</td>
</tr>
<tr>
<td>Fill in forms</td>
<td>48%</td>
</tr>
<tr>
<td>Distribute information</td>
<td>47%</td>
</tr>
</tbody>
</table>
organizational variables as potential predictors of successful technological innovation, including context measures (e.g., size, group type, industrial sector) along with organizational structure and job design characteristics (e.g., centralization, autonomy, comfort, advancement opportunity, and the like) for which standardized assessments have been developed by Quinn, Cammann, and their colleagues (see Quinn & Shepard, 1974) at the University of Michigan. A full description of these variables and a more detailed presentation of analyses is available in Bikson, Gutek, & Mankin (1985).

The most promising of the organizational variables studied—11 in all—were then examined in a series of regression analyses treating each of the nine implementation success indicators in turn as dependent measures. Obtained $F$ values ranged from $0.73$ ($r^2 = .16$, n.s.) to $8.33$ ($r^2 = .68$, $p < .0001$), yielding three significant and three marginally significant findings. Organizational predictors showed weak associations with performance outcomes and somewhat stronger relationships to use measures. They evidenced generally strong relationships to satisfaction variables, being highly significant predictors of satisfaction with the technology ($r^2 = .44$, $p < .001$) and with the job ($r^2 = .68$, $p < .0001$).

Having looked at the regression analyses separately, we next looked at them collectively for patterns among the predictor variables. That is, we wanted to find out which (if any) of these organizational characteristics made systematic contributions to dependent measures across outcome categories. Among them, it is job design characteristics that seem to be most clearly implicated in implementation success. Specifically, variety and challenge in work along with adequacy of resources for task performance emerge as relatively important positive predictors for at least some measures of computer use, user satisfaction, and performance improvements. It is not surprising to find resource adequacy associated with implementation success. Findings for variety and challenge are more noteworthy: They would seem to suggest that the "rationalization" of work and deskilling of jobs can act against the best interests of both employees and employers.

In general, however, the organizational variables studied here do not account for a great deal of variation in implementation success in comparison to the other classes of influence studied. We do not think this means that user context characteristics are unimportant but rather that better dependent measures are needed. We explored most of the standardized survey scales used to represent characteristics of organizations. Although we invariably found high scale reliability (alpha coefficients in the .80s), we are uncertain of scale validity for office work. Most measures of organizational characteristics in the research literature were developed and validated with blue-collar samples and their extension to information workers is problematic. (For instance, an item on the autonomy scale is "I can take breaks when I want," which we suspect has a quite different meaning for office employees than for employees
in manufacturing plants.) Traditional archival measures of organizational variables (e.g., frequency of tardiness, absence from work without an illness excuse, or grievances as indices of job satisfaction) also are difficult to obtain in white-collar settings, especially for higher level employees. Further, problems of response bias (generalized positive or negative response set) should be mentioned with self-report variables, although we found our respondents to be fairly discriminating. Finally, it is possible that some of the most important context characteristics for promoting innovation are the most difficult to operationalize and lack standardized measures. For example, encouragement of initiative, experimentation, independency and other organizational culture values (see Bikson, Stasz, & Mankin, 1985 for an example) may well have strong impacts; but these are not captured in the existing store of organizational variables for use in empirical research.

COMPUTER SYSTEMS AND IMPLEMENTATION SUCCESS

Characteristics of the computer systems introduced into the office settings studied also were expected to have an influence on implementation success. New installations characterized nearly a third of the participating groups who acquired them in 1982; this equipment had been in use for less than a year prior to data collection. In contrast, some groups had used interactive computers for several years, as Table 9.8 shows. The equipment represented a number of manufacturers. The vendors most commonly found include Apple, Digital, Hewlett-Packard, IBM, Wang, and Xerox, with equipment from many other makers less frequently observed. We were surprised at the small proportion of single-vendor sites—most groups have equipment from two or more (see Table 9.9).

The distribution of processing power among work groups is likewise diverse. Archival data revealed the following sorts of computing arrangements. The percent of groups in each arrangement in Table 9.10 sums to more than 100 because the alternatives are not mutually exclusive. Most of the work groups have multiple sources of computing support, reflecting the

<table>
<thead>
<tr>
<th>When First Acquired</th>
<th>% of Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977-79</td>
<td>15%</td>
</tr>
<tr>
<td>1980</td>
<td>21%</td>
</tr>
<tr>
<td>1981</td>
<td>33%</td>
</tr>
<tr>
<td>1982</td>
<td>31%</td>
</tr>
</tbody>
</table>
### TABLE 9.9

Number of Different Vendors
Represented in Work Groups

<table>
<thead>
<tr>
<th>No. of Vendors</th>
<th>% of Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24%</td>
</tr>
<tr>
<td>2</td>
<td>26%</td>
</tr>
<tr>
<td>3</td>
<td>19%</td>
</tr>
<tr>
<td>4</td>
<td>22%</td>
</tr>
<tr>
<td>5</td>
<td>8%</td>
</tr>
<tr>
<td>8</td>
<td>2%</td>
</tr>
</tbody>
</table>

entrance of personal computers into settings already served by some kind of central processing unit.

Our exploration of technology characteristics as influences on successful innovation followed the analytic strategy we pursued in studying organizational characteristics (see prior section). But because there is not a long tradition of behavioral research involving computer system characteristics, we had to develop independent variables for this component of the conceptual framework as a part of the research project. We approached this task from two directions, using both survey data and archival information supplemented by interview responses. In both instances we followed Bair’s (1980, this volume) work by starting with detailed feature lists and constructing more generic variables from them. Our aim was to construct variables that met the criteria specified above, as well as two others; they needed to (a) be independent of particular vendors and specific applications, and (b) represent properties of computer systems that have a relatively direct impact on users.

Work-group members, as part of the survey, were asked to rate the satisfactoriness of specific properties of their computer systems. To learn whether these properties could be combined to form more generic variables we again carried out a factor analysis (see Bikson & Gutek, 1983a). The four resulting factors and the features that define them are presented in Table 9.11; together the factors account for more than 60% of the variance in user responses to

### TABLE 9.10

Source of Processing
Power for Work Groups

<table>
<thead>
<tr>
<th>Computing Support</th>
<th>Percent of Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcomputers</td>
<td>31%</td>
</tr>
<tr>
<td>Mid-size computers</td>
<td>52%</td>
</tr>
<tr>
<td>Mainframe computers</td>
<td>50%</td>
</tr>
</tbody>
</table>
TABLE 9.11
User-Generated Dimensions of Information Technology

<table>
<thead>
<tr>
<th>Factor I</th>
<th>Factor II</th>
<th>Factor III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text or data alteration capability</td>
<td>Promptness of maintenance</td>
<td>Quality of the operating manual</td>
</tr>
<tr>
<td>Text or data entry capability</td>
<td>Quality of maintenance</td>
<td>Type of dialog with the computer</td>
</tr>
<tr>
<td>Organization of stored information</td>
<td>Quality of printout</td>
<td>Response time of the computer</td>
</tr>
<tr>
<td>Information retrieval capability</td>
<td>Quality of the video display</td>
<td></td>
</tr>
<tr>
<td>Appropriateness for your specific job functions</td>
<td>Back-up to prevent file loss</td>
<td></td>
</tr>
<tr>
<td>Error detection and correction</td>
<td>Keyboard layout</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience and comfort of office furniture</td>
</tr>
<tr>
<td>Arrangement of equipment, furniture and space</td>
</tr>
</tbody>
</table>

computer system characteristics. We construe the first factor chiefly in terms of functionality, or goodness of fit between software design and job functions. The second factor, in contrast, emphasizes equipment performance. We interpret the third factor as standing for interaction support—whether users have what they need to take advantage of interactive tools. The user environment is represented by the fourth factor. We regarded these factors as major dimensions of multifunction interactive systems from the user perspective. Accordingly we converted them into predictor variables for further exploration (using a standard factor scoring procedure and averaging the scores within work groups).

Next, we attempted similar procedures with objective (versus perceived) properties of computer systems. Although these properties are "objective" in the sense that they are independent of users' experiences of them, associated variables and measures reflect researcher choices. For example, the number of different vendors represented in a work group's equipment could be
summed and treated as a continuous variable (a proxy for tool diversity with the advantages and disadvantages that entails). We also wanted to represent system complexity in terms of software functions. However, we found we could not simply count and sum the number of different applications without making very arbitrary assumptions. We decided therefore to treat system complexity as a three-level variable (low, medium, high) rated by researchers on the basis of number and type of functions implemented.

Examination of archival data, in contrast to survey data, did not yield a limited and comprehensive set of computer system dimensions. We therefore examined separately a number of hardware and software features that fulfilled the criteria previously suggested and seemed potentially capable of affecting implementation success, adopting an exploration strategy very much like that employed with organizational characteristics. These investigations and trial analyses with many computer system characteristics variously represented yielded eight archivally based variables for further study: shared workstations, electronic mail, system complexity, customized software, user modifiability, number of different vendors, use of microcomputers, and use of minicomputers.

Survey and archival variables—12 in all—were then treated as predictors in regression analyses; as before, the implementation success indicators served as dependent measures. Obtained values of $F$ ranged from $1.14$ ($r^2 = .26$, n.s.) to 5.26 ($r^2 = .62$, $p < .0001$), producing six significant and one marginally significant results among the nine regression analyses. Again, satisfaction outcomes were easiest to account for, overall; however, in contrast to organizational characteristics, system variables were more strongly related to perceived system friendliness ($r^2 = .56$, $p < .01$) and satisfaction with the technology ($r^2 = .55$, $p < .001$) than to job satisfaction ($r^2 = .41$, $p < .05$). In the use category, system properties were marginally associated with percent of users ($r^2 = .34$, $p = .10$) and strongly associated with incorporation of system use into task processes ($r^2 = .62$, $p < .0001$). With respect to performance, the system characteristics studied accounted for 47% of the variance in user-assessed work impacts ($p < .01$) and 42% of the variance in managers' ratings of value-added benefits ($p < .05$).

Next, we looked for patterns within the set of predictor variables, attempting to see whether any of them was systematically related to implementation success across dependent measures. The strongest single predictor variable in the regression equations is whether or not a workstation is shared; exclusive use makes a highly significant contribution to extent of incorporation of interactive tools into task processes, satisfaction with the new technology, and user-rated productivity improvements. Other important variables derived from archival data are having electronic mail (the system property most strongly associated with proportion of group members that are system users), customized software, and user modifiability. Interestingly, user modifiability
makes a marginally negative contribution to perceived system friendliness; however it makes a significant positive contribution to overall satisfaction with the technology and to user-assessed performance benefits. (Table 9.12 summarizes the computer system variables most closely related to implementation success.)

Among survey-based variables, two of the four factorially generated dimensions emerged as consistent positive predictors: functionality (first factor) and interaction (third factor). As might be expected, functionality is strongly related to the extent of incorporation of computer-based tools into day-to-day tasks; it also is a strong predictor of system-related satisfaction measures. The interaction factor makes substantial individual contributions to all three work-group performance outcomes; it also is a significant contributor to system-related satisfaction.

In general, except for having enough workstations to go around, hardware properties seem less important than software properties for predicting implementation success. It is probably inappropriate to compare the relative importance of perceived and objective system properties (because the former are summary variables but there are twice as many of the latter). In our data, however, the factorially generated functionality dimension seems very much like the user's view of customized software (less than 20% of participating work groups had wholly off-the-shelf software). The interaction dimension also appears like a user-based counterpart of user modifiability (an archival variable). That is, we think there is some convergence between the subjective and objective measures. This is not to imply that there is an unambiguous set of system properties that predict implementation success. As previously noted, there is not a straightforward relationship between the functionality and interaction factors. The same seems to hold true of important objective properties—systems that are customized are not typically easy to modify. These exploratory findings suggest that the implementation process involves implicit or explicit choices between success criteria (e.g.,

<p>| TABLE 9.12 |</p>
<table>
<thead>
<tr>
<th>Technology Characteristics That Affect Success</th>
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</thead>
<tbody>
<tr>
<td><strong>User-Generated Properties:</strong></td>
</tr>
<tr>
<td>Functionality</td>
</tr>
<tr>
<td>Interaction support</td>
</tr>
<tr>
<td><strong>Archivally Based Properties:</strong></td>
</tr>
<tr>
<td>Unshared workstations</td>
</tr>
<tr>
<td>Communication</td>
</tr>
<tr>
<td>Customized software</td>
</tr>
<tr>
<td>User modifiability</td>
</tr>
</tbody>
</table>
"friendliness" vs. longer term satisfaction with interactive tools). Nonetheless, for the outcome measures used here, computer system variables outweighed the collection of organizational characteristics we studied in trying to account for variation in implementation success.

IMPLEMENTATION PROCESSES AND SUCCESSFUL OUTCOMES

The organizations participating in this research introduced computer systems into their offices because employees at all levels of the hierarchy were engaged in a great many information tasks; they aimed at improving workgroup performance in varied ways by providing advanced information tools (see previous). On the basis of previous innovation studies, we believed that characteristics of the processes by which new technologies were introduced into extant work settings would have a great deal to do with the success of these efforts.

Although there is a long history of innovation research, the major concepts it has investigated were not readily translated into variables for this study. Again, we began the exploration by developing measures of implementation process characteristics that are importantly linked to innovation success in existing literature, investigating their relationship to success indicators in a variety of univariate analyses. Implementation process data were drawn primarily from managerial interviews, supplemented by survey responses, researcher ratings, and archival information (see Bikson, Gutek & Mankin, 1985, for a more detailed representation of implementation variable development).

Available innovation research gives considerable importance to stage in the implementation process (Bikson et al., 1981) as an explanatory variable. Initially, any technological innovation in a work setting is thought to disrupt regular work repertoires and stimulate a great deal of change as the organization adapts to new capabilities. Gradually the turbulence is expected to give way to smoother transition processes until finally a new stasis is reached. Although this thesis accords with common sense, it is not clear how to operationalize "stage." Often stage is equated with "age" of an innovation, or length of time since first access to the new tool; however the passage of time can signal delays and errors as readily as progress. Similarly, amount of turbulence (or degree of system change since initial implementation) can be treated as a stage measure; however stasis may be a sign of too early routinization rather than full deployment of system capabilities. And former theories fail to take into account that if the state of the art is rapidly advancing—as with computer-based tools—continuous system evolution rather than stasis in user settings should be expected. Consequently we also included a three-level researcher-rated stage variable, referring to whether computer system use
was just beginning, well under way, or fully incorporated into work-group behavior within a setting.

A second key characteristic identified in prior innovation research is user participation in the decision process. Several study instruments included items that tapped this issue. The best was a survey item asking users whether or not they took part in decisions about organizing work in relation to the system; the proportion of positive responses per work group is significantly associated with implementation success across dependent measures. (Managers’ judgments about the extent of user participation in decisionmaking are correlated with but systematically higher than users’ own judgments.)

Varied other implementation strategy characteristics were also examined, such as focus of efforts (technology focus, group focus, sociotechnical balance), status of the work group with respect to technology diffusion in the organization, voluntary vs. mandatory transition to new tools for employees, and user satisfaction with the level of learning support (see Bikson & Gutek, 1983b, for an extended discussion of training in computer-mediated work settings). In all, a total of 12 implementation variables representing either stage or process characteristics were selected on the basis of preliminary explorations for further study in regression analyses using success indicators in the three outcome categories as dependent measures.

These analyses yielded values of $F$ ranging from 0.98 ($r^2 = .26$, n.s.) to 4.41 ($r^2 = .61$, $p < .001$); the set of implementation process characteristics explained a significant amount of variation in eight of nine dependent measures, leaving only manager-assessed productivity improvements out of account. Once more, all three satisfaction outcomes were readily predicted; the strongest finding was for satisfaction with the new technology ($r^2 = .61$, $p < .001$). Implementation process variables also were associated significantly with use measures; in this outcome domain the strongest regression equation had proportion of users within a work group as the dependent measure ($r^2 = .57$, $p < .001$). Within the area of performance outcomes, implementation process characteristics evidenced significant relationships to users’ assessments of performance improvements ($r^2 = .54$, $p < .01$) and to managerial judgments about value-added benefits ($r^2 = .57$, $p < .001$).

As a last step in the exploration, we investigated the regression analyses for systematically influential predictor variables. Consistent with earlier innovation findings, stage of implementation as rated by researchers makes strong individual contributions to system use and work-group performance measures. Age of system (from archival data) shows a very similar but less strong pattern of influence. On the other hand, amount of system change since initial implementation (from managerial interviews) is a distinctly negative predictor. Not surprisingly, the age of a system shows moderate positive correlations with both the stage of its implementation and the degree of change it has undergone in the process (Table 9.13 summarizes implementation process variables most consistently associated with successful outcomes).
Among implementation process features, a balanced social and technical approach is a strong predictor, contributing particularly to tool acceptance and percent of users as well as to managers' assessments of both productivity and value-added gains. Another important predictor variable is user satisfaction with learning support, associated with incorporation of computer-based tools into task processes and user ratings of performance benefits; it also contributes to satisfaction with the technology. Other implementation strategy elements that make consistent but less strong contributions to outcome measures include the organization's positive orientation toward change (a standardized survey measure from Cammann, Fichman, Jenkins, & Klesh, 1978) and user participation in the decision process. Finally, the work group's diffusion status—its potential role in technology transfer—emerged as a positive predictor. Groups that were official pilot projects were very successful, perhaps because they received a great deal of organizational hand-holding and encouragement. But groups who regarded themselves as leading examples, as innovators in their milieus, also were quite effective. At the other extreme were groups who believed they would have no impact or might even be seen as a negative example. Conversely, the total proportion of work groups in the same site who were also implementing interactive technology yielded a similar but weaker and negative pattern of influence.

Exploring implementation characteristics suggests that in the transition to advanced information technology—like other organizational innovations—the nature of the process can importantly affect the nature of the outcomes. This conclusion merits emphasis in view of the fact that a sizeable proportion of organizations focus their innovation efforts on the technology itself, paying little attention to the change process. For example, most of the organizations taking part in this study did not have a budget earmarked for implementation and could not estimate the cost of meetings, planning procedures, and other hands-on activities associated with the conversion to computer-based tools. Further, although our findings are coherent with prior research in highlighting the influence of implementation process characteristics, they diverge in suggesting that a successful transition to computer technology will be indi-
cated by organizational stasis; in contrast, we suspect the mark of successful implementation with a rapidly advancing technology may be an organization's learning to manage change rather than attempting to minimize it (Bikson & Eveland, 1985; Bikson, Stasz, & Mankin, 1985).

**DISCUSSION**

In reviewing what we learned from studying how organizations introduced computer-based procedures into white-collar work, we believe some of the nonfindings are as important as the findings. Among the widely touted problems that we did not observe in our sample, first of all, was resistance to computer use. Many sources (see literature review in Bikson et al., 1981) had predicted that employees would not be willing to interact directly with information systems—some targeting sex (men will not use a keyboard), others citing age (older employees cannot make the transition), and still others basing their expectations on job status (managers won't work at machines). As Table 9.3 shows, none of these predictions was borne out by the data we collected. In fact, rather than finding equipment going unused, we found that limited computing resources was by far the more common problem—work groups reported they needed more workstations and more processing power.

Second, we did not observe software "unfriendliness" to be a major problem. In the main, employees are relatively satisfied with the applications they use (see Table 9.4). This is not to say they have access to the best of interfaces, but only that functionality seems to outweigh friendliness in the work groups we studied. Employees appear to be highly motivated to use good tools, and there is some evidence that friendliness (or, ease of use by untrained individuals) may stand in the way of functionality in the long run (see Bikson & Gutek, 1983a). On the other hand, effective use of a complex interactive tool requires better learning support for employees than many organizations are prepared to provide (see Bikson & Gutek, 1983b).

There are, however, a number of issues raised and not resolved in this research. These issues concern how organizations can make multifunction interactive systems into effective work tools, given that employees are willing and able to use them. For instance, we have observed that although organizations are fairly successful at getting applications to support highly specific functions they have not been notably successful at supporting generic functions. Table 9.4 provides evidence that there are many white-collar activities performed in common by a sizeable proportion of employees in an organization, regardless of their departmental affiliation or occupational status (e.g., communication, file organization, and management). Future research needs to address the question of how to enhance the generic information and communication environments in which more narrow, task-specific applications are embedded.
Next, subsequent research needs to investigate system functionality for upper level employees. Although over three-fourths of the organizations in our sample aimed at providing support for higher management and professionals, they were most successful at supporting lower level employees (clerical, secretarial, and technical). Major efficiency gains are observed at that level (see Table 9.5), but they have little impact on overall costs or value-added improvements. Further, we suppose this issue is related to improved support for generic activities—because it is higher level groups who perform the most varied but general information and communication functions. Although the question of managerial and professional support has not gone unrecognized, the research reported here suggests two reasons why it has not been adequately resolved.

- Developing “the professional workstation” or “the managerial workstation” is probably not a fruitful direction. As we have underscored, the functions performed in common by higher level employees are currently most lacking in support. Second, research at the work-group level has made it evident that these employees do not in the main work as individuals—rather they act as members of teams that include other managers or professionals as well as support staff. Facilitation of shared work by teams of employees, many of whom perform information-related functions in common, is likely to prove more productive (cf. Bair, this volume).

- Developing interfaces to systems that can be used without risk of error by almost anyone, with little training or effort, also is not likely to be effective. We have not found evidence that having to learn how to use a system is aversive to higher level employees (even though quality training is difficult to deliver). Moreover, systems that are “idiom-proof” also are probably competency-proof, preventing well-educated employees from manipulating interactive tools in ways that take advantage of their established skills in task domains. Thus questions of how to increase the power rather than the simplicity of user interfaces merit more attention (cf. Bikson & Gutek, 1983b; Bikson, Stasz, & Mankin, 1985).

Further, there is need for research that explores the links between multifunction interactive systems and organizational performance. Our explorations suggest that where outcomes are readily measurable (in increased output units or decreased input units) they do not represent major organizational impacts. Information and communication—critical elements in an organization’s products as well as processes—are not readily assumed under the manufacturing productivity paradigm. Further, we have observed that even when we rely on such measures they are the least readily linked in systematic ways to the characteristics of organizational contexts, computer sys-
tems and implementation processes reported here. It is not yet clear how interactive tools affect basic missions and task processes in white-collar work groups, and how these in turn can affect organizational performance. Although examples of dramatic technology-related benefits have surfaced in the literature (e.g., Bikson, Stasz, & Mankin, 1985; Hammer, 1984), we are still unable to define the relationship between the capabilities of flexible, powerful computer systems and the performance of organizations in the information economy.

Finally, there remains a substantial amount of work to be done in developing a research paradigm that will enable cumulative contributions to knowledge about advanced technology in information intensive work. The study reported here is exploratory and suggestive. Although we believe the conceptual framework on which it is based has a great deal of utility for research on technology transfer and utilization, methodological efforts are needed to develop and validate key variables and their measures. In particular, multiple measures of the same variables will help in distinguishing patterns of relationship among the phenomena studied from method artifacts such as response bias in self-reports. More importantly, experimental and longitudinal research is needed to identify causal relationships among variables. As the state of the technical art continues to advance, learning what can be generalized from previous implementation experiences will contribute both to innovation research and to innovation processes in organizations.
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