A RAND NOTE

Technology Transfer as a Framework for Understanding Social Impacts of Computerization

T. K. Bikson, J. D. Eveland

March 1990

RAND

The research described in this report was supported by Grant IRI-8813519 from the National Science Foundation.

This Note contains an offprint of RAND research originally published in a journal or book. The text is reproduced here, with permission of the original publisher.

The RAND Publication Series: The Report is the principal publication documenting and transmitting RAND's major research findings and final research results. The RAND Note reports other outputs of sponsored research for general distribution. Publications of The RAND Corporation do not necessarily reflect the opinions or policies of the sponsors of RAND research.

Published by The RAND Corporation
1700 Main Street, P.O. Box 2138, Santa Monica, CA 90406-2138

A RAND NOTE

N-3113-NSF

Technology Transfer as a Framework for Understanding Social Impacts of Computerization

T. K. Bikson, J. D. Eveland

March 1990

Supported by the
National Science Foundation

RAND

TECHNOLOGY TRANSFER AS A FRAMEWORK FOR UNDERSTANDING SOCIAL IMPACTS OF COMPUTERIZATION

T.K. Bikson and J.D. Eveland
Behavioral Sciences Department, The RAND Corporation, P.O. Box 2138, Santa Monica CA 90406-2138 (United States)

ABSTRACT

A technology transfer framework is proposed as an appropriate model for understanding the computerization of information intensive work. This framework regards outcomes of attempts to introduce computer based tools into ongoing work as a function of three key sources of effect: features of the new technology; characteristics of the organizational context; and properties of the implementation process. Among them, the implementation process itself--the steps taken to embed a new tool in an extant setting--is most closely linked to social impacts. Research results are reviewed to corroborate and refine the model in relation to computer based work, using it to identify implementation process variables predictive of successful outcomes. Implications for positive change management are discussed.

1 INTRODUCTION

A major thesis guiding current RAND research on social aspects of computerization is that computerization can be understood as an instance of technological innovation in organizations. If so, much of what has been learned about the successful transfer and utilization of other new technologies can be applied to understanding how best to introduce new computer-based tools into information intensive work.

The chief conclusion from research based on this conceptual framework is that properties of the implementation process--the sequence of events that starts with the selection of a new tool and ends with its incorporation into ongoing work--are strong predictors of subsequent organizational outcomes. In what follows we briefly explain why characteristics of the change process are critical determinants of the social impacts of computerization. Then we describe the technology transfer framework in more detail, reviewing research results that have helped to corroborate and refine it.

Reprinted from *Work with Computers: Organizational, Management, Stress and Health Aspects*, M. J. Smith and G. Salvendy (eds.), © 1989 by Elsevier Science Publishers B.V. Reprinted by permission.

2 FOCUS ON THE IMPLEMENTATION PROCESS

The study of technological innovation has a long history of its own and has and been the subject of a number of critical reviews (Berman and McLaughlin, 1978; Bikson and Eveland, 1986; Bikson et al., 1981; Rogers, 1983; Tornatzky et al., 1983; Yin et al., 1978). Traditionally innovation has been seen as a process that occurs in the stages depicted in Figure 1.

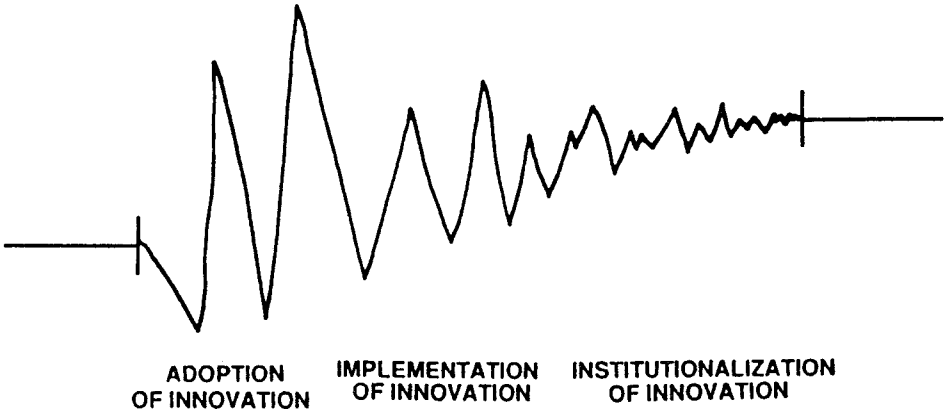

Fig. 1. Stages of innovation

That is, prior to the decision to adopt a new technology, the organization is supposed to be in a state of equilibrium. By contrast, the period that immediately follows is expected to involve major changes as the innovation is being implemented. If all goes well, however, this stage should give way to a new stasis as the technology becomes fully routinized in day-to-day work.

In applying this stage-theoretic view to research on computerization, we expected to find that the point of adoption (e.g., early vs. late) and correlates of the adoption decision (e.g., reasons for adopting) were critical predictors of successful innovation. In fact, we learned that there is no "point" of adoption, and "the adoption decision" is not a single event at a specifiable time (cf. Bikson et al., 1987). Rather, adoption of computer-based tools is better understood as a more extended process that involves agenda setting, negotiating, experimenting and the like as well as decisionmaking (cf. Eveland, 1979). It is difficult to know, either conceptually or empirically, where adoption leaves off and implementation begins.

A second hypothesis generated by the traditional view is that the mark of successful implementation is stasis; innovation ends with improved organizational routines. In contrast, we learned that there is no end to implementation processes while the technological state of the art is rapidly advancing (cf. Bikson et al., 1985; Bikson, 1987). Successful transfer of flexible interactive tools is associated with continued and reciprocal changes in tasks and their supporting technologies, while unchanging routines are more likely to signal failure.

It follows, then, that understanding technological innovation--at least in the case of computerization--requires a focus on implementation processes. The technology transfer framework described below incorporates this emphasis.

3 TECHNOLOGY TRANSFER FRAMEWORK

Across varied types of innovations and a diverse range of organizational settings, common factors consistently emerge in research addressed to technology transfer and utilization. As Figure 2 illustrates, an adequate

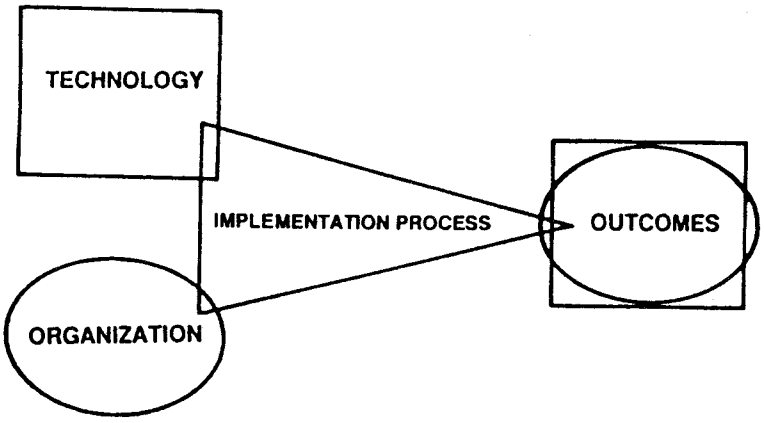

Fig. 2. Technology transfer framework

conceptual framework for understanding the impacts of new technologies in organizations must include three major components: the technology itself, the organizational context into which it is being introduced, and the process of embedding the technology in the context--the implementation process. Further, our research supports the inherent interrelatedness of the three components (Bikson and Eveland, 1986; Stasz et al., 1986).

3.1 Organizational Context

For purposes of studying computerization, we targeted work groups as the appropriate setting. A review of level-of-analysis issues suggested that, while the individual user is too narrow a context, the organization as a whole is probably too wide. Consequently, we chose "primary work systems," defined (following Trist, 1981) as identifiable and bounded subsystems of organizations such as line departments; they have multiple members whose activities are organized by a common mission and work flow. So defined, groups are taken to be the primary users of computer based tools.

3.2 Computer Based Technology

For conceptualizing the technology to be transferred to a work group, we have relied on the "web" model proposed by Kling and Scacchi (1982). That is, computer based tools are task diverse and loosely bundled innovations (cf. Yin et al., 1978; Rice and Rogers, 1980). It is appropriate to regard them, not as discrete products, but rather as complex infrastructures for the support of work. Any new tool, for instance, will likely be transferred to an extant technology environment characterized by equipment and software from multiple vendors and a mix of system ages and types.

3.3 Implementation Process

An implementation process can be construed quite generically as the translation of any tool or technique or method from knowledge or design into practice (cf. Tornatzky et al., 1983). So defined, it includes activities that are both symbolic (e.g., planning, deciding, negotiating, agreeing) and behavioral (e.g., installing, training, modifying). As portrayed in Figure 2, implementation processes are efforts to fit an available technology into a functioning organizational unit.

The technology transfer model we employ thus assumes a "mutual adaptation" model of successful implementation. That is, it predicts that new tools can and should change in the course of being integrated into a particular setting even as the work group must change to assimilate its new technical capabilities (Bikson et al., 1981). The outcomes of computerization are viewed as an interrelated function of the organizational setting and the new technology as both are reciprocally adjusted by implementation

This view of the computerization of information work suggests it has much to learn from sociotechnical systems analysis, which originated in industrial research (Trist, 1981) but aptly characterizes white collar organizations as well. On this analysis, a work unit must be seen as as comprising a technical system, made up of tools and procedures, plus a social system, made up of roles and relationships among work group members; and the systems are so linked that changes in one, of necessity, will have consequences for the other.

Computerization, then, can be expected to generate continuing change whose outcomes are not wholly predictable in advance. This follows from the sociotechnical principle of "incompletion," whereby no system design is ever "finished" but is always being changed by use. And it follows from the mutual adaptation theory of implementation, in which individuals are seen as "reinventing" their tools and tasks. Moreover, it is readily corroborated by anecdotal reports as well as empirical research showing users doing things with their computer systems that neither they nor the system designers could have anticipated (Eveland and Bikson, 1989; Bikson et al., 1987; Bikson et al., 1985).

3.4 Outcomes

Having claimed that the outcomes from technological innovation cannot be specified in advance, how are its social impacts to be anticipated? This question is as problematic for work groups as it is for researchers. Most managers would like to be able to plan the outcomes of computerization "down to the last detail" (Bikson et al., 1987) even as researchers strive to develop precise causal models for explaining them. On the other hand, the technology transfer framework outlined here implies that the effects of computer based tools are highly context dependent and susceptible to substantial variability in use. How, then, can it be used to understand and plan for the social impacts of computerization?

The answer, we believe, lies in attending to properties of the implementation process. Reviewing industrial research literature as well as studies of organizational innovation (e.g., Tornatzky et al., 1983) suggests there are characteristics of change processes themselves that are systematically associated with positive outcomes. Consequently organizations would do well to de-emphasize outcomes and give greater to change management strategies in the introduction of computer based tools.

The next section summarizes implementation process characteristics significantly associated with positive social impacts in recent RAND research on computerization.

4 PROPERTIES OF SUCCESSFUL IMPLEMENTATION PROCESSES

Literature reviews provided us with a number of variables potentially likely to influence the outcomes of implementation processes. We examined them quantitatively in a large scale cross-sectional study of white collar work units (55 user departments in 26 different organizations) and qualitatively in case studies (Bikson et al., 1987; Stasz et al., 1986; Bikson et al., 1985). This research operationalized success in terms of proportion of intended users actually using a new tool, users' assessments of the tool's capabilities, and evaluations by users and managers of its effects on group processes and products.

For convenience, the properties that we found to be the strongest predictors of successful implementation outcomes are discussed in three categories below.

4.1 Planning

Positive impacts are associated with flexible planning efforts that are sociotechnical in nature. Given our conceptual framework, we were not surprised to learn that successful transfer of computer based tools is associated with flexible planning. We were, however, surprised that management may regard this as oxymoronic--it is often assumed that real plans are detailed and fixed. But in our sample, precise plans were typically observed to be rigid and centralized, allowing little opportunity for technology adaptation, task reinvention, experimentation, or even mid-course correction.

Moreover, in 40 percent of the work groups we studied, planning focused almost exclusively on the new software or hardware to be introduced. In another 30 percent, conversion of tasks from manual or batch processes to interactive systems formed the focus. On the other hand, in the most successful sites, planning efforts gave much more balanced attention to social and technical components of the implementation process. They believed that accomplishment of work group missions would require high performance from both, a precept in accord with the sociotechnical maxim

of joint optimization. As an interviewee in one of our case studies put it, "That's why 'Business' always comes before 'Systems' in the Business Systems department."

4.2 Action

Inevitably implementation is a people-based process. It turns on hundreds of choices made and actions taken on a daily basis by varied actors throughout a process that can take months or years. Prior research has identified user involvement in implementation decisions as a major influence on successful outcomes. Our research corroborates participative decisionmaking in all aspects of the implementation process as a strong predictor of successful transition to new computer based tools.

While it is clear that technology expertise has a strong role to play in this process, the need for user involvement is sometimes less obvious. And it may even seem to hinder the process. One member of a work group described it this way:

> When you put a user together with a system designer, what you get at first is nothing like what either of them had in mind.
>
> Then they work on it.

Put simply, however, user participation appears to be the most effective way to link complex tool development to substantive task performance.

Second, in order to get full advantage from the new tools, users must be provided with high quality and long term learning support. As computer technology becomes part of the infrastructure of information work, its sociotechnical nature becomes more salient. While participative decisionmaking helps assure that the tools will conform to work group needs, supplying appropriate knowledge resources will help users assimilate the new technology and adapt their work styles appropriately. Thus we found rated adequacy of overall support for learning to use computer-based tools a significant correlate of implementation success.

Interestingly, the importance of learning support for effective computer use is widely acknowledged but rarely manifest in organizations (Bikson, 1987). Most of the organizations in our research provided brief beginning level training. Afterward, users were expected to progress with little besides "self-instruction." When asked about options for learning more

advanced techniques, the modal user response was "I can do it on my own time." The primary day-to-day source of additional technical information and assistance was another user in the work group who happened to be more proficient. Said one such local resource, "We're always running up against the limits of our own expertise."

4.3 Commitment

Historically, innovation literature has emphasized the importance of attitudinal factors but chiefly in relation to the adoption of new technology rather than its utilization. But as we noted earlier, the variables that predict adoption are not significantly associated with implementation success. We therefore sought attitudinal variables that could represent a work group's commitment to the post-adoption change process.

One such predictor is a group's "change orientation." As measured by survey items drawn from the Michigan Assessment of Organizations, a group's change orientation is reflected in the extent to which its members view an envisioned change as a positive, problem-solving and achievable goal--and one that would benefit management and employees alike.

A second attitudinal variable, drawn from interview data, is what we have termed "diffusion status." It represents a work group's conception of its place in the spectrum of technological innovation. Some groups regard themselves as setting a trend or serving as an example as they take on a new computer based tool. For instance, one member of such a group said "We don't think anyone in the business is within 5 years of us." A positive orientation toward change and the perception of being on the leading edge characterized successful implementation efforts in our research.

5 DISCUSSION

Technological innovation in general and the transfer of new computer based tools in particular is frequently said to be hampered by employees' resistance to change. Our research provides very little support for that view. On the contrary, we have encountered countless examples of individuals doing old tasks in new ways and doing new tasks they would not have anticipated when they entered their current jobs. By self report as

well as by management assessment (Bikson et al., 1987), they tend also to be doing more work and meeting higher performance standards.

We suggest that resistance to change is observed more often in the organization than in its employees. For instance, organizations seldom acknowledge changes in employee skills, tasks or standards with changes in job titles, job descriptions/grades, or pay. They are reluctant to invest in training and learning resources that would better support employees' use of advanced tools. And they remain ambivalent about the need to facilitate technological innovation--only a minority see a continuing role for organizations in this area (Bikson et al., 1988).

Perhaps part of the problem lies with older frameworks for understanding innovation, which emphasized stasis as the mark of a successful transition. Given that there is no foreseeable end to the advance of computer based tools, organizations will be involved in implementation processes for a long time to come. They would do well to aim at managing change successfully rather than at minimizing it.

6 REFERENCES

Berman, P. and McLaughlin, M., 1978. Federal Programs Supporting Educational Change: Factors Affecting Implementation and Continuation. The RAND Corporation, R-1589/7-HEW, Santa Monica CA.

Bikson, T.K., 1987. Cognitive Press in Computer Mediated Work. In: G. Salvendy, S. Sauter and J.J. Hurrell, Jr. (eds.). Social, Ergonomic and Stress Aspects of Work with Computers, Elsevier, Amsterdam, 353-364.

Bikson, T.K. and Eveland, J.D., 1986. New Office Technology: Planning for People, Pergamon Press, New York.

Bikson, T.K., Eveland, J.D. and Gutek, B.A., 1988. Flexible Interactive Technologies for Multi-Person Tasks: Current Problems and Future Prospects. In: M. Olson (ed.), Technological Support for Work Group Collaboration, Erlbaum, Hillsdale NJ, 1-24.

Bikson, T.K., Gutek, B.A. and Mankin, D.A., 1987. Implementing Computerized Procedures in Office Settings: Influences and Outcomes. The RAND Corporation, R-3077-NSF, Santa Monica CA.

Bikson, T.K., Gutek, B.A. and Mankin, D.A., 1981. Implementing Computerized Procedures in Office Settings: Review of Relevant Literature. The RAND Corporation, P-6697, Santa Monica CA.

Bikson, T.K., Stasz, C., and Mankin, D.A., 1985. Computer Mediated Work: Individual and Organizational Impact in One Corporate Headquarters. The RAND Corporation, R-3308-OTA, Santa Monica CA.

Eveland, J.D., 1979. Issues in Using the Concept of "Adoption of Innovations." Journal of Technology Transfer, 4(1), 1-13.

Eveland, J.D. and Bikson, T.K., 1989. Work Group Structures and Computer Support: A Field Experiment. ACM Transactions on Office Information Systems, in press.

Kling, R. and Scacchi, W., 1982. The Web of Computing: Computer Technology as Social Organization. Advances in Computers, 21, 2-60.

Rice, R.E. and Rogers, E.M., 1980. Reinvention in the Innovation Process. Knowledge 1(4), 499-514.

Rogers, E.M., 1983. The Diffusion of Innovations, Free Press (second edition), New York.

Stasz, C., Bikson, T.K. and Shapiro, N.Z., 1986. Assessing the Forest Service's Implementation of an Agency-Wide Information System: An Exploratory Study. The RAND Corporation, N-2463-USFS, Santa Monica CA.

Tornatzky, L. G. and others, 1983. The Process of Technological Innovation: Reviewing the Literature. National Science Foundation, Washington DC.

Trist, E. L., 1981. The Sociotechnical Perspective: The Evolution of Sociotechnical Systems as a Conceptual Framework and as an Action Research Program. In: A.H. Van de Ven and W. F. Joyce (eds.). Perspectives on Organization Design and Behavior, Wiley & Sons, New York, 19-75.

Yin, R.K., Quick, S. and Marks, E., 1978. Changing Urban Bureaucracies: How New Practices Become Routinized (final report and appendixes). The RAND Corporation, R-2277-NSF, Santa Monica CA.