1990

DESKTOP COMPUTERIZATION AS A CONTINUING PROCESS

Mary Zmuidzinas
University of California, Irvine

Rob Kling
University of California, Irvine

Joey George
University of Arizona

DESKTOP COMPUTERIZATION AS A CONTINUING PROCESS

Mary Zmuidzinas
Public Policy Research Organization
University of California, Irvine

Rob Kling
Public Policy Research Organization and
Department of Information and Computer Science
University of California, Irvine

Joey George
Department of MIS
University of Arizona

ABSTRACT

This article presents the first longitudinal, quantitative, analyses of the continuing process of computerization in work groups. We argue that computerization should be conceptualized as a continuing process, not the commonly held static view. We also argue that computerization in the workplace is not as dynamic as portrayed in popular technology magazines. Conceptualizing computerization as a continuing process has implications for how work is transformed in computerized work settings, and how we study work transformations. Longer periods of time between implementation and observations of changes in work, and repeated observations are needed to capture the dynamics, and to distinguish between stable and transient patterns, of technology and work.

We present findings from two years of survey data on the role of desktop computing in the work of 39 extensively computerized work groups. Data were collected from a self-administered survey and through in-person interviews in 1988 and in 1989. We characterize computerization interventions as consisting of four elements: equipment, infrastructure, social organization of computing, and control patterns. We present descriptive data for each of these four elements. Technological elements of computerization interventions (e.g., type of equipment, extensiveness of deployment and use) have become more elaborate between 1988 and 1989. However, the social patterns of interventions (e.g., computing infrastructure) have *not* changed much, while the use and availability of technology have. Our preliminary analyses of changes in work suggest that work groups are working harder.

1. INTRODUCTION

Computerization is a potentially powerful catalyst for changing white-collar work (Kraut 1987). Studies of computerization and work transformation suggest that work life is most likely to change in content, in social contact, and in structure.

Some analysts predict poor working conditions as the most likely outcome for white-collar workers. Others predict that working conditions will improve. Finally, other analysts maintain that outcomes of computerization interventions will be different, depending on various contingencies.

When reading the literature on computing technology in the workplace, it is possible to pick up two contrasting views of how technology is used. Readers of magazines with an eye on the marketplace (e.g., *PC Magazine*, *Byte*, *Mac World*) might assume that organizations are adopting and using the latest technology at a very rapid pace. These magazines present a picture of rapid and widespread deployment and uses of new technologies such as laptops, portable PCs, desktop publishing, and graphical user interfaces, as well as enhancements to word processing, database, and spreadsheet packages.

On the other hand, some analysts of work transformation assume that computerization and its uses are static. Once computer systems are in place, there are no significant changes in the kinds of equipment or their uses. Other analysts (Giuliano 1982) are mute about how they conceptualize or study the computerization process, but they present static pictures when they focus on "stages" without discussing transitions between stages or dynamics within stages. For example, in their study of productivity and quality of worklife, Kraut, Dumais, and Koch (1989) used a lagged, time-series design; they carefully considered the time frame for measuring changes in work. To be sure that the changes or effects were a result of the new

technology and not byproducts of a transition, they measured changes in work four months after (in addition to one month prior and one month after) the introduction of the technology. Implicit in this design is their conceptualization of computerization: computerization was either absent (before) or present (after).

Kling and Iacono (1989) view computerization as a complex intervention that includes both social and technical choices. These social and technical choices *develop over time*, and are the contingencies that predict work transformation outcomes. Bikson, Stasz, and Eveland (1990) in their study of computerization at the Forest Service, found that even in the late-stages of computerization,[1] there are computing issues that need to be solved. As Bikson, Stasz, and Eveland point out, there is comparatively little research about late-stage computerization in the literature on the computerization of work. The focus of the Bikson, Stasz, and Eveland study was on the systems (hardware and software), with some attention to computing support, expertise, and culture. We believe that computerization is dynamic; *both the social and technical choices* may change over time. We also suspect that the *social choices may be more important than the technical choices* in predicting work transformations (i.e., access to equipment may be more important than some of the design differences between systems). In this paper we examine the computerization process in ten organizations that we studied over the past two years. We begin by describing our study. We then discuss and present our observations on the social and technical choices that comprise an *ongoing* "complex intervention" for clerical and professional work groups.

2. METHOD

2.1 Design

Our study is longitudinal, covering a period of three years. We collected both survey and interview data. We surveyed multiple groups from multiple organizations and industries because this provides for variability in factors (e.g., equipment, infrastructure, and control patterns) that we believe are important in explaining how computerization transforms work. In addition, surveying a diverse set of about forty work groups in ten organizations allows us to generalize beyond a single, possibly idiosyncratic, group, organization, industry, or occupation.

However, surveys do not provide a good basis for adequately understanding the process of computerization. Surveys provide broad, general information, not situational and context specific information which gives detailed, vivid insights about the ways that computerization transforms work. Because of this, we supplemented our survey data with interviews. These interviews allow us to understand computerization processes in more detail.

2.2 Sample

Our primary unit of analysis is the work group. Work groups are located within larger organizational units – departments, divisions – which shape some work group practices about the organization of work, the nature of internal labor markets, and computerization strategies. There are several plausible criteria for drawing work group boundaries (Thompson 1967). We used a simple criterion: people reporting to the same supervisor were clustered into the same work group.

We selected work groups which had sufficient desktop computing equipment such that its use might significantly shape work practices and work life. Based on pilot studies, we selected work groups which had at least one terminal or workstation for every two members. The sheer number of workstations indicates that these work groups are leading-edge groups. However, these groups are not avant-garde groups – they are not well equipped with the latest technologies. Only two groups use local area networks (LANs), few do desktop publishing, and no groups use groupware, except for crude mainframe electronic mail systems. Although the amount of equipment these groups have may limit the generalizability of our findings to groups that are extensively computerized, we believe that our findings are generalizable to "future" work groups. Organizations and work groups are generally becoming more computerized. In addition, our work groups are "mainstream" users of computing, groups that are not computerized now are likely to computerize in a similar, mainstream, fashion.

Work groups differ along many other dimensions as well as availability of computing – size, occupational mix, computerization strategy, turnover rates, etc. In 1988 we gathered data from 38 white collar groups which differed in their occupational mix: primarily clerical (14), primarily professional or semi-professional (17), and a mixture of professional and clerical workers (7). Twenty-eight of our sample of 38 work groups came from three large organizations – INSURE, AIRCRAFT, and COAST PHARMACEUTICALS. The other ten came from seven other organizations.

Between 1988 and 1989, three of the work groups in our 1988 sample were "disbanded" and a new work group was "created," thus resulting in a difference of two groups between 1988 and 1989.[2] In this paper, our analyses include only those groups that participated both in 1988, and in 1989. As a result, our sample consists of 35 work groups, of which 11 are clerical, 17 are professional, and 7 are mixed groups (see Table 1).

Table 1. Survey Sample: Distribution of Work Groups Among Organizations and Occupational Mix

OCCUPATIONAL MIX OF WORK GROUPS	ORGANIZATION			
	Insure	Aircraft	Coast	Other
Clerical				
1988	4[a]	2[b]	2	6
1989	3	0	2	6
Mixed				
1988	3	0	2	2
1989	3	0	2	2
Professionals				
1988	5	10	0	2
1989	5	11[c]	0	2

[a] One of these groups was not included in our analyses because it was disbanded between 1988 and 1989.
[b] These two groups were not included in our analyses because they were disbanded between 1988 and 1989.
[c] The new group created in 1989 was not included in our analyses.

In 1988, these 35 work groups varied in size from 3 to 27 members, with a mean size of 11.3 members. In 1989, these 35 groups varied in size from 2 to 30 members, with a mean size of 10.5 members. Thus, the range and average size of the existing work groups remained fairly stable between the two years.

2.3 Data Collection

We administered a closed response questionnaire to every member of the 38 work groups in the Spring of 1988 and 36 work groups in the Spring of 1989.[3] We are interested in many aspects of work transformation and the questionnaire covers a broad range of topics. The questionnaire included approximately 200 closed-response questions covering topics such as the patterns of the respondents' computer use, job characteristics, patterns of computer use and computing practices in the work group, and changes in work life that the respondent attributed to desktop computerization.[4]

In the spring of 1988, we conducted approximately 50 hour-long interviews. We focussed these interviews in eight work groups and selected informants that represented each job type and hierarchical level. We also interviewed some people outside of the work groups who influenced computing arrangements within the work group, such as top managers who controlled key resources and computer support staff. In the spring of 1989, we selected work groups that had reported the most substantial changes on many of our measures and we conducted 27 hour-long interviews. These interviews focussed on the changes in computing and work that had occurred within the work group and changes that had occurred within the organization that had affected the work group. We interviewed both supervisors and their workers. We usually reinterviewed the same workers from the previous year that we found to be the most knowledgeable and reliable informants.

2.4 Index Construction

Because our primary unit of analysis is the work group, we aggregated individual questionnaire items, to the work group level by calculating the mean response from all the individual work group members' responses. In addition to analyzing responses to individual survey items, we created summary indices. These indices measured access to desktop computing, control or participation in desktop computing, adequacy of infrastructure, work effort, and supervisors' expectations. The indices are presented in Appendix 1 along with a brief description, items that form the index, the number of items that the indices consist of, and measures of their internal consistency for both years (Cronbach's alpha).

2.5 Scaling

Most survey items were coded on a seven point agreement scale ranging from 1 (No!No!No!) to 4 (Neutral) to 7 (Yes!Yes!Yes!). Some survey items assessed changes

attributable to desktop computing.[5] These items were coded on a seven point change scale ranging from 1 (Greatly decreased) to 4 (No change) to 7 (Greatly increased). For clarity, index scales ranging from 1 to 7 with 4 as a midpoint were recoded to -3 to +3 with 0 as a midpoint. Consequently, index scores less than 0 indicate disagreement or decreases; scores greater than 0 indicate agreement or increases.

3. COMPUTERIZATION AS AN ONGOING COMPLEX INTERVENTION

When organizations computerize, they can make many decisions. What kinds of technologies will be used? How will they be organized? How will these technologies be used? How will users be supported? These decisions involve both technical and social choices and are made simultaneously (Mumford 1982; Pava 1983). These social and technical choices develop over time in a particular social setting and can be made either explicitly or can develop as part of a computerization strategy (Kling 1987). Kling and Iacono (1989) have identified and categorized the elements of a desktop computerization into four major areas: equipment, social organization of work, control patterns, and infrastructure. Kling, Iacono, and George (1990) reported that patterns of desktop computer use differ among clerical, mixed, and professional work groups. Thus, we will distinguish between occupational categories in our discussion of computerization interventions. We limit our discussion to a contrast of clerical and professional work groups.[6]

The results we discuss in this paper are based on our analyses of the 1988 and 1989 survey data. In our presentation of data, we include tests of statistical significance for those interested in the reliability of our findings. However, we avoid using these tests as a criteria for guiding our discussion of our findings. Statistical significance - a measure of confidence - will increase as the sample size increases for the same "effect." It is too common for information systems researchers to report primarily statistically significant differences, whether or not they are important, and to ignore important differences that do not meet an acceptable threshold of statistical significance. We will focus on socially significant differences.

3.1 Equipment: Kinds, Extensiveness, and Use

The equipment element of an intervention includes the choices of kinds of equipment and extensiveness of equipment to be used. Different kinds of hardware and software acquired enable or facilitate (but do not shape) certain organizational behaviors (Kling and Iacono 1989). For example, shared systems allow communication with electronic mail, whereas isolated minicomputers make electronic mail impossible. However, the ability to use electronic mail does not guarantee that it will be used on a regular basis.

The ratio of workstations (terminals or PCs) to members of a work group measures the extensiveness of desktop computing (Kling and Iacono 1989). Extensively computerized work groups have a greater potential of routinely using computing than do work groups with less equipment per capita. However, even in the most extensively computerized work group, it is possible that computing will not be used routinely for certain tasks.

3.1.1 Kinds of Desktop Computing Equipment

Six items of our survey provided us with information on the frequency of use of various kinds of desktop equipment. We asked about the use of microcomputers as stand-alone equipment, as terminals linked to software packages installed on a mini or mainframe computer, and/or in local area networks (LANs). In addition, we assessed the use of computer terminals, dedicated word processors, and reports containing data from computer files.

Our respondents used most kinds of equipment more frequently in 1989 than in 1988 (see Table 2).[7] Professionals used microcomputers as stand alone equipment most often, whereas clerks used computer terminals most often. Professionals used microcomputers more often than clerks. However, clerks increased their use of microcomputers – especially as terminals linked to mini or mainframe computers. We suspect that professionals primarily use stand-alone equipment and clerical groups use terminals because work groups specialize on the kinds of work activities (tasks) they do, and consequently on the kinds of equipment they use.

3.1.2 Extensiveness of Desktop Computing Equipment

We believe that extensively computerized work groups have the potential to transform work to a greater extent than work groups that are sparsely computerized. We surveyed work groups that we found to be among the most extensively computerized work groups based on our pilot research in 1987. For the purposes of our study, we defined the extensiveness of desktop computerization by the ratio of workstations (terminals or PCs) that are "on or near the desks" of individuals in a work group to the total number of work group members.

Several of our survey items measured the extensiveness of computing equipment. We measured the proximity of workstations to individuals, and how often "not enough equipment" was a problem individuals encountered. From individual responses we computed percentage scores at the work group level. These scores reflected the percentage of work group members who reported that equipment was "on or within reach of their desks." To assess the extent to which "not enough equipment" was a problem, we used a 5-point scale ranging from 0 (never a problem) to 4 (always a problem).

Table 2. Type of Computing Equipment Used: Mean Use of Different Types of Desktop Computing Equipment

TYPE OF EQUIPMENT	YEAR	OCCUPATIONAL MIX OF WORK GROUPS	
		CLERICAL	PROFESSIONAL
MICROCOMPUTER AS STAND-ALONE EQUIPMENT	1988	3.04***	5.51[a]***
	1989	4.01***	5.88[a]***
MICROCOMPUTER AS TERMINAL LINKED TO MINI OR MAINFRAME	1988	1.77[c]	2.29[a]
	1989	3.08[c]	3.08[c]
COMPUTER TERMINAL	1988	4.07	3.21
	1989	4.24	3.59

t-tests within year, between occupational groups:
***p<.001

Paired t-tests between groups, within occupational groups:
[a] p<.05;
[c] p<.001

The scales for these items were: 1 = almost never, 2 = once or twice a year, 3 = once or twice a quarter, 4 = once or twice a month, 5 = once or twice a week, 6 = once or twice a day, 7 = almost all of the time.

Table 3. Ownership of Workstations: Mean of Fraction of Members of Each Group Who Have Workstations on Their Desk

YEAR	OCCUPATIONAL MIX OF WORK GROUPS	
	Clerical	Professional
1988	74% (N=11)	81% (N=17)
1989	82% (N=11)	83% (N=17)

In 1988, clerical group members were less likely than professional groups to have equipment on their desks (see Table 3). However, between 1988 and 1989, the number of work group members who had equipment on their desks substantially increased. In fact, in 1989, clerical groups were just as likely as professional groups to have equipment on their desks.

In 1988, both clerical and professional groups reported that equipment shortages (including printers) were sometimes a problem. Equipment shortages, were among the top three problems reported by both professional and clerical groups in 1988. In 1989, the problem had noticeably declined – to the bottom half of our list of 15 problems.[8]

The groups participating in our study are becoming more extensively equipped. Equipment is more likely to be located on or near workers' desks than it was before. Respondents report that lack of equipment is less of a problem, perhaps because of increased proximity as much as sheer counts of workstations.

3.1.3 Uses of Desktop Computing

Work groups are using desktop computing in "richer" ways over the span of two years. In 1988, clerical groups spent an average of 15.5 hours at any workstation during an average work week; professional groups spent an average of 17.1 hours. In 1988, clerical groups were learning an average of one new software package or system; professionals groups were learning two new packages or systems. In 1989 both professional and clerical groups spent more time at workstations – they reported spending over half of their work week (clerks - 22.4 hours, professionals - 22.7 hours) at workstations.[9] Both clerical and professional groups still reported learning, on average, one new software package or system.

Our survey assessed the frequency with which work groups used desktop computing for seventeen tasks (process text, code or enter data, create spreadsheets, electronic mail, etc.). Professional groups used computing most often for text processing, less often for data entry, searching records,

Table 4. Work with Computing: Mean Frequency of Desktop Computing Usage for Seven Most Common Tasks of Seventeen

TASKS	OCCUPATIONAL MIX OF WORK GROUPS			
	Clerical		Professional	
	1988	1989	1988	1989
Process text	4.26**	4.32*	5.52**	5.37*
Data entry	5.12**	5.14**	4.05**	3.85**
Search records	5.39**	5.29***	4.05**	3.80***
Create spreadsheets	1.64***	1.87***	3.53***	3.80***
Numerical calculations	1.82***	2.24**	3.64***	4.01**
Compute statistics	1.49***	1.82	2.86***[a]	2.50[a]
Specialized systems tasks	2.00	2.85*	2.10	1.99

t-tests within year, between occupational groups:
* $p < .05$
** $p < .01$
*** $p < .001$

Paired t-tests between years, within occupational groups:
[a] $p < .05$

The scales for these items were: 1 = almost never, 2 = once or twice a year, 3 = once or twice a quarter, 4 = once or twice a month, 5 = once or twice a week, 6 = once or twice a day, 7 = almost all of the time.

Table 5. Variety of Work with Computing Mean Number of Tasks for Which Computing is Used at Least Once or Twice a Year

YEAR	OCCUPATIONAL MIX OF WORK GROUPS	
	Clerical	Professional
1988	10**	14[b]**
1989	12***	16[b]***

t-tests within year, between occupational groups:
** $p < .01$ differences between groups
*** $p < .001$ differences between groups

Paired t-tests between years, within occupational groups:
[b] $p < .01$ differences between years

working with spreadsheets and numerical calculations, and least often for computing statistics and specialized systems tasks (see Table 4). Clerical groups, on the other hand, used computing most frequently for searching records and data entry, less frequently for processing text, and least frequently for working with spreadsheets, numerical calculations, computing statistics, and specialized systems tasks (see Table 4). Although there were shifts in ranking within the three "tiers" of frequency of computing use, the most striking finding is the relative stability of the three tiers of uses between the two years (see Table 4).

To compare the variety of tasks for which computing is used, we created a work group measure (MLTFNC) by counting all the tasks (from the list of 17) for which computing was used at least once or twice a year. We used this low threshold of computing use for simplicity: to distinguish those tasks for which work groups were using computing from those for which work groups were not using computing. It is possible for work groups to use one package or application for a variety of tasks (e.g., data entry and searching records). Our measure does not reflect the number of packages or applications that are being used.

In 1988 and in 1989, professional groups consistently used desktop computing equipment for a greater variety of tasks than clerical groups (see Table 5). Respondents (both clerks and professionals) increased the number of tasks for which they used computing between 1988 and 1989 (see Table 5). Some individuals have very specialized tasks and may use only one computing application. Other individuals

have a wider variety of tasks and may use several computing applications. Although our data do not discern how many individuals are using computing for a greater number of tasks, they do show at least one work group member is using computing for a greater number of tasks. We suspect that it takes time to learn to use computing. Work groups begin using computing for a small subset of their tasks and, over time, as some applications become routine, work groups begin to learn new applications.

To better understand the variety of tasks for which professionals and clerical groups use desktop computing, we compared the specific tasks that showed changes in use between 1988 and 1989. Referring back to Table 4, clerical groups increased their use of desktop computing for numerical calculations, computing statistics, and specialized-systems tasks. Professionals, on the other hand, increased their use of desktop computing for numerical calculations and working with spreadsheets. Thus although both professionals and clerical groups are using computing more often for a variety of tasks, the "mixture" of tasks for which they use computing is not the same. Professionals and clerical groups are increasing their use of desktop computing for a greater variety of *different* tasks. Professionals do different kinds of work than do clerks (e.g., budgeting versus data entry), and this difference is reflected in the kinds of tasks for which they are increasing their use of desktop computing.

3.1.4 Summary

We previously identified an element of a complex intervention of computerization that we have called "equipment." This "equipment" element represents the technological choices organizations make about equipment from a large array of choices in the market. We have found that, in extensively computerized groups, these decisions are ngoing, that both the equipment and the use of equipment have become more extensive between 1988 and 1989. Professionals and clerical groups use the same kinds of equipment and are about equally extensively equipped. However, the use of equipment is somewhat more restricted for clerical groups than it is for professional groups, most likely because they do different kinds of work. Professional groups use microcomputers, primarily as stand-alone equipment, for processing text. They also use computing more frequently for a wider variety of tasks than do clerical groups. Clerical groups, on the other hand, use computer terminals or microcomputers as terminals most often for searching records and data entry.

A static view of computing may best fit the computing patterns of clerical groups. Although clerks are spending more time at workstations and are increasing the variety of tasks for which they use computing, the number of tasks is still somewhat limited. It is possible that some clerks use only one application for most of their tasks (e.g data entry and searching records). However, even so, we found substantial transformations in the technology and work of clerical groups (see Jewett and Kling 1990b). In contrast, the dynamic view may be more appropriate for professional groups because they use computing for a wider variety of tasks; they are most likely using a number of applications.

Zuboff (1988) argues that the best time to study changes in work due to computerization is a short time after implementation. In the first year of our study, work groups were already well equipped, these groups were well past initial implementations. Yet, we still found that both professional and clerical groups were getting more equipment, spending more time at workstations, and using computing for a greater number of tasks. Because computing is not static, we believe that it is equally important (if not more so) to study changes in work after lengthy periods of time following the implementation of computing.

3.2 Social Organization of Work: Access

The social organization element describes the ways in which work is organized or reorganized in a computerization effort (Kling and Iacono 1989). Access to desktop computing equipment is one of the ways that work can be organized (or reorganized). For example, in a work group, computers can be located on each member's desk; alternatively, they could be located in a designated central area. Having computers on members' desks allows them more control over their use of computing in their work and enables them to use computing more routinely. Having computers located in a central area allows members less control over their use of computing and increases the extent to which they have to share with other members.

We used two measures to assess access to computerization: the extent of sharing of computing equipment and an index of access (see Appendix 1). The majority of both professional and clerical group members reported "good" access – that they do *not* have to share their equipment frequently. Both professional and clerical groups reported less sharing of equipment in 1989. However, professional group members shared their equipment somewhat less than did clerical group members (see Table 6).

Our index of access (NMDACE) showed the same patterns as in Table 6. Both clerical and professional groups reported that they had sufficient access to computing equipment.[10] Access to computing improved slightly for both professional and clerical groups. Professional groups consistently had "better" access to computing equipment than did clerical groups. The difference in access between professional and clerical groups reflects their difference in occupational status.

Table 6. Access to Desktop Computing: Mean of Fraction of Members of Each Work Group Who Have Their Own Equipment and *Hardly Ever Have to Share It*

YEAR	OCCUPATIONAL MIX OF WORK GROUPS	
	Clerical	Professional
1988	83% (N=11)	89% (N=17)
1989	87% (N=11)	93% (N=17)

Table 7. Participation in Desktop Computing Decisions: Mean Participation in Decision Making and Control Over Computing (NMDPRT)

YEAR	OCCUPATIONAL MIX OF WORK GROUPS	
	Clerical	Professional
1988	-.36***	.92***
1989	-.18***	.92***

t-tests within year, between occupational groups: *** $p < .001$ differences between groups
The scale for NMDPRT ranges from -3 (disagree) to 0 to +3 (agree).

3.3 Control Patterns: Participation

Control patterns describe the extent to which workers have control or are involved in computerization decisions (Kling and Iacono 1989). Involvement or non-involvement in computerization decisions can result in different outcomes. For example, in one of the work groups we studied, some work group members were involved in computerization decisions, others were not. Those members that were involved displayed expertise in computing skills, expressed favorable attitudes and satisfaction with computing. Members that were not involved in the computerization effort had minimal knowledge of computing, had difficulty solving simple problems (e.g., fixing a data entry error), and expressed feelings of mistrust of the systems.

Professional groups consistently participated in decision making and had more control over their computing than did clerical groups (see Table 7). Clerical groups were less involved, and had less control over their computing than professionals. These differences in control between clerical and professional groups, which reflect occupational status, remained stable between 1988 and 1989.

3.4 Infrastructure

Computing infrastructure includes all the resources and practices required to help people adequately use computer systems to carry out their work (Kling and Scacchi 1982; Kling 1987). It can be either formal (established by an organization) or informal (established by members within or across units of an organization), or some combination of both strategies (Kling 1987). Computer use requires skill; the presence or lack of skill can mediate the use of equipment and the way work changes. For example, if workers lack necessary skills, they may use powerful systems in limited ways. Skill can be acquired through formal or informal training. In an extreme but instructive case, some members of an extensively computerized work group we studied received neither formal nor informal training in using the word processing software which was the primary application on their microcomputers. They did not use their computer for their work, and let it sit unused while they continued using typewriters.

Both professional and clerical groups consistently reported minimal computing support (see Table 8). However, professional groups reported slightly better support than did clerical groups. In 1989, the range of infrastructure widened - professional and clerical groups reported both stronger and weaker infrastructure (see Table 8). We also explored individual work groups for changes in infrastructure. With the extensiveness of computerization increasing, we expected that the infrastructure might also improve. However, the changes in infrastructure were not unidirectional. For about half of the work groups, infrastructure improved; for the other half, it worsened. These changes did not reflect occupational status differences - professional groups were as likely as clerical groups to report worsened infrastructure[11]

How work group infrastructure changes is important because infrastructure can shape how work changes. For example, Lepore, Kling, Iacono, and George (1989) report that infrastructure moderated the effects of implementation strategies[12] on six aspects of changes in work. Compared to grass-roots groups with inadequate infrastructure and top-down groups with either inadequate or adequate infrastructure, grass-roots groups with adequate infrastruc-

Table 8. Infrastructure Range and Mean Computing Infrastructure for Work Groups (INFRA)

YEAR		OCCUPATIONAL MIX OF WORK GROUPS	
		Clerical	Professional
1988	Mean	.05	.37
	Range	-.87 to 1.00	-.36 to .98
1989	Mean	-.06	.34
	Range	-1.28 to 1.20	-.43 to 1.08

The scale for INFRA ranges from -3 (disagree) to 0 to +3 (agree).

ture reported the best work outcomes.[13] In addition, top-down groups with adequate infrastructure consistently reported better work outcomes than top-down groups with inadequate infrastructure. We suspect that groups reporting worsened infrastructure might also report worsened work conditions (e.g., increase in work effort); whereas groups reporting improved infrastructure might report improved work conditions. (This will be discussed further in our forthcoming paper on changes in work.)

Its not clear why infrastructure improved for some groups and worsened for others. Jewett and Kling (1990b) argue that work group managers help shape the computing infrastructure for their groups. They examine two work groups that illustrate the roles of work group managers in shaping changes in work and in developing infrastructure. In one group, computing was viewed by the managers as a simple substitute for manual procedures; consequently, employees were left to rely on themselves and their co-workers for support. In another group, computing was viewed as transformative in nature – the manager of this group provided training programs and continuing support for the new computer system. Some of the changes in work group infrastructure we report, might be attributable to different work group managers' beliefs about computing and their efforts to support their staff.

An additional explanation for changes in work group computing infrastructure is the substantial effort it can take to maintain a complex computing environment. Jewett and Kling (1990a) illustrate the substantial knowledge, training, and labor efforts it takes to operate such a computing environment. With the acquisition of new equipment, increase in amount of time and variety of computing uses, additional support is often needed. Unless work group managers (or management or other work group members) make a conscious effort and have the available staff, knowledge, and resources to improve infrastructure, group computing infrastructure will decline as computing becomes more elaborate.

4. WORKING HARDER

Because of the expansion of computing equipment and its uses, we expected work groups to report corresponding ease in getting their work done. However, our data surprised us: work groups reported that they are working harder. Desktop computerization is transforming work by making it more "sweat intensive" in the groups we surveyed. We found that supervisors expectations are increasing,[14] groups are doing more work,[15] they are experiencing increased time pressures,[16] and they are working harder.[17] Respondents in both years, on average, reported working an average of between 40 and 44 hours per week. Thus, respondents are doing more in 1989, at an increased pace, while they are at work.

5. CONCLUSIONS

We characterize desktop computerization as an *ongoing* complex intervention with four elements - equipment, social organization, control patterns, and infrastructure. Organizations make choices regarding the equipment they want to purchase or use, what kinds of tasks the equipment will be used for, who will use the equipment, who will have access to the equipment, who will make decisions about computerization, and if and how they will provide support for those users. In the work groups we studied, the social choices of a computerization intervention (access to equipment and control patterns) reflected occupational status[18] and showed little change. Access to equipment was already high in 1988 and only slightly improved in 1989. Control over computing and computing decisions was modest and did not change. Professional groups consistently had better access and more control than clerical groups. The technological or equipment elements of the computerization interventions in these groups are becoming more extensive. Work groups have more equipment, use computing more often, and for a wider variety of tasks. However, the computing infrastructure, a social resource,

that is needed to support users, did not always improve with increasing amounts of time spent and usage of desktop computerization. Taken together, these findings show that computerization is an ongoing process (see also Bikson, Stasz, and Eveland 1990).

These changes in technology are important clues that the workplace is dynamic. Contrary to our findings, a static view of computing would predict that the amount of time spent at workstations and the uses of computing do not change. If we rely on the static view of computing which shapes much of the research, we are likely to miss the dynamics of work groups. However, accounts in popular technology magazines portray a stream of annual improvements with new kinds of technology coming out every few years. If only a tiny fraction of the tens of thousands of work groups acquire leading-edge equipment, they still can create a visible national market. Work groups in our study do *not* adopt new technologies in an attempt to stay current with the wide array of innovations in the marketplace. We have not observed (either through our surveys or interviews) many groups acquiring laptops, portables, LANs, very sophisticated equipment or applications each year. In addition to the simple costs of purchase and questions about the values received from these technologies, organizations do not acquire new technologies at a faster pace due to the enormous effort it takes to install, train, track, and maintain the technology (see Jewett and Kling 1990a).

Conceptualizing computerization as an ongoing process has implications for how work is transformed. Because uses of technology are constantly changing, we cannot assume that the changes in work today will be the only changes in work we will observe. This continuous process also has implications for how we study computerization. There is no distinct "before" and "after"; changes in technology and work are dynamic. This suggests that longer time periods between implementation and the study of work need to be considered when conducting studies of work transformation. It also suggests that, to distinguish between stable patterns and transient patterns of work transformation, repeated measures (over time) are necessary. In a forthcoming paper, we present the changes in work we've observed and discuss the relative impact of both technological and social choices in predicting these changes in work.

6. ACKNOWLEDGEMENTS

Norman Anthonisen, Jim Brennan, Stephen Lepore, and Tom Jewett helped us conduct some of the research that supports this article. Paul Attewell and Tora Bikson made very helpful comments on an earlier draft of this paper. This research was funded by National Science Foundation Grant #IRI-87-09613. Please direct all correspondence to Professor Rob Kling.

7. REFERENCES

Bikson, T.; Stasz, C.; and Eveland, J. D. *Plus Ca Change, Plus Ca Change.* RAND Corporation, Unpublished Manuscript, 1990.

Giuliano, V. "The Mechanization of Office Work." *Scientific American*, Volume 247, 1982, pp. 148-164.

Jewett, T., and Kling, R. *Computing in a Social Science Research Team: Infrastructure, Strategies and Skills.* Unpublished Manuscript, 1990a.

Jewett, T., and Kling, R. "The Work Group Manager's Role in Developing Computing Infrastructure." *Proceedings of the Fifth Conference on Office Information Systems*, Cambridge, Massachusetts, 1990b, pp. 69-78.

Kling, R. "Defining the Boundaries of Computing Across Complex Organizations." In R. Boland and R. Hirschheim (eds.), *Critical Issues in Information Systems Research.* New York: Wiley, 1987.

Kling, R., and Iacono, S. "Desktop Computing and the Organization of Work." In Forester (ed.), *Computers in the Human Context*, Cambridge, Massachusetts: MIT Press, 1989.

Kling, R.; Iacono, S.; and George, J. "Occupational Power, Patterns of Desktop Computer Use, and Quality of Worklife." In K. Kaiser and H. J. Oppeland (eds.), *Desktop Information Technology.* Amsterdam: North Holland, 1990.

Kling, R., and Scacchi, W. "The Web of Computing: Computer Technology as Social Organization." *Advances in Computers*, Volume 21, 1982, pp. 1-90.

Kraut, R. *Technology and the Transformation of White Collar Work.* Hillsdale, New Jersey: Lawrence Erlbaum, 1987.

Kraut, R.; Dumais, S.; and Koch, S. "Computerization, Productivity, and Quality of Work-Life." *Communications of the ACM*, Volume 32, Number 2, 1989, pp. 220-238.

Lepore, S. J.; Kling, R.; Iacono, S.; and George, J. "Implementing Desktop Computing, Infrastructure and Quality of Worklife." In J. I. DeGross, J. C. Henderson, and B. R. Konsynski (eds.), *Proceedings of the Tenth International Conference on Information Systems*, Boston, Massachusetts, 1989.

Mumford, E. *Designing Human Systems.* Manchester, England: Manchester Business School Publications, 1982.

Pava, C. *Managing New Office Technology: An Organizational Strategy.* New York: Free Press, 1983.

Thompson, J. D. *Organizations in Action*. Englewood Cliffs, New Jersey: Prentice-Hall, 1967.

Zuboff, S. *In the Age of the Smart Machine: The Future of Work and Power*. New York: Basic Books, 1988.

8. ENDNOTES

1. They referred to this as the "internalization" of computerization which is the stage when technology is fully incorporated into the day to day tasks of an organization.

2. All three of the groups that were disbanded were clerical groups: one at INSURE and two at AIR-CRAFT. The new group that was "created" was a professional group at AIRCRAFT.

3. These surveys are the first and second waves of our three year longitudinal study.

4. With the exception of minor changes in rewording of 19 questions, (for example, the word "not" in questionnaire items was capitalized in 1989, but not in 1988) and the addition of 18 new items, the questionnaires administered in 1988 and 1989 were identical. In the spring of 1988, we received 357 completed and usable questionnaires (86 percent response rate). In the spring of 1989, we received 294 completed and usable questionnaires (79 percent response rate).

5. In 1988, respondents assessed changes between 1988 and "when there was less equipment or the systems or software were more primitive." In 1989, respondents assessed changes attributable to desktop computing for the past year.

6. Refer to Kling, Iacono, and George (1990) for a description of how mixed work groups use desktop computing.

7. The use of microcomputers in local area networks and computer generated reports decreased. However, this decrease was not substantial.

8. 1988 clerical groups mean is 1.84; professional groups mean is 1.95. 1989 clerical groups mean is 1.45; professional groups mean is 1.55. The scale ranges from 0, "never a problem" to 2, "sometimes a problem" to 4, "always a problem." Paired t-tests between professional groups indicated the decrease in the 1988 and 1989 means was statistically significant at $p<.01$.

9. Paired samples t-tests indicate the mean increase is statistically significant for both increases: $p=.001$ for clerical groups, and $p=.007$ for professional groups.

10. 1988 NMDACE mean for clerical groups was .80; for professional groups it was 1.09. The 1989 NMDACE mean for clerical groups was .88; for professional groups it was 1.30. The scale for NMDACE ranges from -3 (disagree) to 0 to +3 (agree). A t-test between occupational groups in 1989 indicates that the difference in means is statistically significant at $p<.05$.

11. Infrastructure worsened for about half of the clerical and half of the professional groups.

12. In some organizations, computerization decisions are planned and directed by managers outside of the computerizing work groups. We refer to these types of implementation processes as "top-down" strategies. In other organizations, work groups make many of their own decisions about computerization. We refer to these types of implementations as "grass-roots" strategies. The primary distinction between these types of implementation strategies is the *locus* of control over computerization decisions. In top-down strategies, the locus is outside the work group; in grass-roots strategies, the locus is within the work group (Kling and Iacono 1989).

13. Grass-roots groups with adequate infrastructure reported the most complex work, the most enriched jobs, the most expertise and involvement in computing, the most participation in decisions in work, the greatest increase in job enrichment attributed to desktop computing, and the greatest decreases in work effort attributed to desktop computing.

14. 1988 mean for CGWEXP was 1.29; 1989 mean was .97. The scale for CGWEXP ranges from -3 to 0 to +3.

15. The 1988 mean for the item "The use of desktop computing has (increased or decreased) the amount of work that you now have to do" was 4.79; the 1989 mean was 4.94. The scale ranges from 1 to 4 to 7.

16. The 1988 mean for the item "The use of desktop computing has (increased or decreased) time pressure at work" was 4.21; the 1989 mean was 4.41. The scale for this item ranges from 1 to 4 to 7. Paired t-tests indicate that the mean increase is statistically significant at $p<.05$.

17. The 1988 mean for NIWEFF was -.47; the 1989 mean was -.35. The scale for NIWEFF ranges from -3 to 0 to +3.

18. See also Kling, Iacono and George (1990).

Appendix 1

Reliabilities, Description, Items from Indices, and Number of Items Forming Indices

Index	Description	Items	Alphas	
			1988	1989
NMDPRT	Participation in decision making and control over computerization.	I have little influence over the computerization of my work group*.	.80	.80
		I actively seek ways to computerize my tasks.		
		I often discuss desktop computing with others in my work group.		
		I choose some of the software or systems that I use in my work.		
		I have made changes which improve the comfort of my computing work area (e.g., moved my workstation, adjusted the lighting, or changed chairs).		
		I have little influence over the activities I use a desktop computer for*.		
		Individuals have little say about how they use desktop computing equipment in their work*.		
		People have some choice about the software or systems that they use.		
		People in our work group discuss desktop computing when we get together for coffee breaks, lunch, or informal hallway discussions.		
NMDACE	Access to desktop computer equipment.	I would like to use desktop computing for more work but access to equipment is restricted*.	.67	.69
		My current computing arrangements do not allow me to be as productive as I would like to be*.		
		Most everyone who wants immediate access to desktop computing gets access.		
		Some policies and procedures inhibit people from using desktop computing effectively*.		
		Management discourages substantial use of desktop computing for many of us in the work group*.		

INFRA	Adequacy of training received and adequacy of adjunct resources.	Most everyone has received adequate formal training about the systems and applications we use.	.64	.63
		The desktop computing training that I have received in my organization has not been sufficient for my needs*.		
		I am encouraged to take time to learn new computing skills during work hours.		
		I can rarely find adequate help when desktop computing problems arise*.		
		Most everyone lacks some desktop computing skills which hurts our work performance*.		
NIWEFF	Current work effort. Effort needed to get a job done.	I must take many steps in order to complete most tasks or projects.	.70	.73
		I usually need to work longer than the normal workday to get my job done.		
		I am often confused due to frequent changes in our work practices.		
		I often experience difficulties trying to complete my work tasks on time.		
CGWEXP[1]	Changes in group productivity expectations	Supervisors' expectations about the accuracy of work.	.72	.72
		Supervisors' expectations about the professional appearance of work products.		
		Expectations about how quickly work should be done.		

* The scores for these items were reversed for direction. (e.g. "I would like to use desktop computing for more work but access to equipment is restricted." indicates *not* having access, thus it was reversed so that positive scores would indicate having access).

[1] The instructions preceding this section read: "In your opinion, has the use of desktop computing in your work group over the past year increased or decreased:"