COMPUTER MEDIATED WORK: A COMPARATIVE STUDY OF STRUCTURED AND SEMI-STRUCTURED JOBS IN SAVINGS BANKS

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Abstract

It is argued that the consistent evidence of psychosomatic stress problems associated with the use of computer systems in offices may be the result of the redesign of work stemming from the implementation of these systems. This proposition is tested with samples of mortgage loan servicing clerks (N=1282) and financial investment officers (N=131) in 78 Mutual Savings Banks.

Evidence is presented that workers, in the structured job, making more intense use of computer systems do have a poorer task environment than those making less use of systems. This occurs because the resulting job tends to be more interdependent and involve greater demands than without an application system, although several other factors interact reducing these affects somewhat. Productivity is also increased, and the task environment interacts in complex ways with the characteristics of the system. Various strategies are suggested for correcting the negative effects including providing workers with more decision latitude in the selection of work methods and making it easier to obtain problem solving assistance.

No relationship is found between productivity, performance, or the task environment and system use or characteristics for the semi-structured job. It is concluded that although application systems have considerable negative consequences for office work environments, the strength of these affects depend upon the level of the job.

1.0 INTRODUCTION

For over twenty years managers and researchers have been concerned about automation and its effect on office workers. Would the move to mechanized offices improve the lot of workers - resulting in jobs with more variety, better opportunities to acquire skills, increased leasure time, and better working life quality than before - or, would this change reduce the number of jobs and make those that remained less interesting? This issue has taken on a sense of urgency as computers have become commonplace in offices and as the pace of office automation surpasses expectations. Recently a number of articles have appeared speculating on whether office automation will have beneficial or adverse effects for office workers (Zuboff 1982, Nussbaum 1983, Stanley 1983). A Senator has proposed that a special commission be appointed to investigate the issue in detail and legislation to regulate the use of CRT(VDT) displays is being introduced in several states.

Yet, with all of this interest there are remarkably few studies that either present empirical data on the effects of automation on office workers or a model by which the mechanics of these effects can be understood. In the absence of either empirical data or a model, one is left with suppositions based mainly on individual beliefs and values.

This paper reviews previous studies of office work and then presents a model of the work environment, based on an information processing approach to task accomplishment, that permits representing the changes in tasks that are likely to take place as a result of automation. This model is tested with data from samples of loan servicing workers and financial investment officers in Mutual Savings Banks. The results of the study are interpreted for managers and researchers.

2.0 PRIOR RESEARCH

It is convenient to separate the research about computers and office work into two categories or themes. The first deals with the micro effects of computer mediated work on individuals and groups. Here the primary concerns are with the quality of working life and productivity. The second theme involves macro effects of the distribution of jobs in the labor force, the major issue being displacement. For the most part, because of different methodologies and different levels of analysis, researchers tend to treat these themes separately. Commentators, however, frequently confuse the two streams of research, drawing inferences between them that are not warranted. For example, concluding that the total number of jobs will be reduced because automation can be used to perform (most of) a particular job. One might summarize by observing that the second theme deals with current and future patterns of employment, while the first is concerned with the quality of the jobs that remain. This paper will concentrate on the first theme - the micro effects of computer mediated work on individuals and groups, leaving comments

about patterns of employment for the conclusion.

2.1 The Utility Study

One of the earliest and most influential studies of the effect of automation on office work was conducted by Mann and Williams (1960) in the accounting and sales departments of a large utility. Their study was longitudinal, involving over 850 employees using interviews and questionnaires. The authors observed that after a period of dynamic change caused by the introduction of computer based transaction processing and record keeping systems, a state of relative equilibrium emerged characterized by:

1. An increased level of formalization. Rules and regulations were substituted for individual decision making.

2. Autonomy for setting the work pace (for both individuals and groups) was reduced. For example, work could no longer be held from one day to the next. Related to this finding was the observation that control became more centralized; it was vested in a few positions.

3. The interdependence among workers increased and there was greater need for coordination. For example, a breakdown in one part of the operation affected other parts' ability to do their job.

4. Because their errors were more visible (that is, more easily detected and traceable), workers became more accountable for their work.

5. A number of jobs were eliminated and there was some reduction in specialization (that is, some jobs were combined into an enlarged job). There was no change, however, in the departments' average job grade.

6. The new systems permitted a reduction in cost.

The authors were careful to point out that they could not tell whether the aggregate effect of these changes were positive or negative for either individuals or the organization. Yet, by values commonly accepted as being desirable in work situations (Griffin 1983), the jobs for the most part appear to have become poorer. Mann and Williams did conclude that the changes in jobs were substantial, but uneven in their affect; the dislocations and loss of duties and jobs were serious problems for some workers, for others, the change was a game.

2.2 Further Studies

A variety of researchers took up Mann and Williams' (1960) theme with mixed results. Hoos (1961), Hardin (1960, 1960a), and Lee (1965, 1965a) all found results somewhat similar to Mann and Williams' in that office work tended to be more routine and specialized, there was greater use of objective standards in assessing individual performance, and freedom and autonomy decreased after a move to computer application systems. Yet, Hoos found that jobs were less interdependent, while Lee found, consistent with Mann and Williams' results, that jobs were more interdependent. Lee found that variety increased and that the clerical content of jobs had decreased, while the managerial content had increased, resulting in a greater required skill level. Hoos concluded the opposite, that skill level was reduced. Hardin observed that the differences between computer mediated and manual jobs were small, probably not even significant. Shepard (1971), in studying a relatively narrow issue of worker control, concluded that there was no difference in autonomy between

workers performing mechanized and non-mechanized jobs. Whistler (1970) observed, somewhat incongruously, that clerical jobs were less autonomous, that control over human behavior was tightened, that interdependence decreased, and that skill level was increased with the use of computer systems.

Several new themes emerged. Most studies found that the pace of the job and the work load had increased after a move to computer based systems (Hoos 1960, Lee 1965). The number of deadlines also appeared to increase (Hoos 1960, Hardin 1960, Lee 1965) suggesting more pressure to accomplish the job.

Outcomes became mixed in with task descriptive measures. For example, Hoos (1960), observed that turnover and absenteeism increased, while satisfaction decreased. Hardin (1960) also notes that satisfaction decreased, while Lee (1965) found that satisfaction increased. In fact, outcomes became so interwoven with task descriptive concepts that Meyer (1968) was prompted to observe, "there is an assumption in the previous research that has not been tested: that the impact of automation is direct; that it is not mediated by formal structure." He goes on to observe that the effects of automation on human behavior should be assesed only after taking into account the changes in organizational process which automation itself engenders.

More recently, Bjorn-Andersen (1976) and Bradley (1977) have reported studies where the nature and content of the work was redefined after a move to computer based systems in offices. The resulting jobs became more structured and formalized and workers had

less control over the pace and methods of work than prior to the change. Using a crude index of job content, Bjorn-Andersen determined that clerks that made direct use of systems had a poorer job than clerks that used systems indirectly. Clerks that used the most technically advanced system directly had the poorest job of all! Bradley observed, in her study, that the work load was heavier, more hectic, and more stressful for clerks that used computer systems in their jobs than those that did not.

Although the results of these studies are inconsistent as to precisely what dimensions of work change, the overall conclusion is that jobs of workers using computer systems do change and that they somehow become poorer.

2.3 CRT (VDT) Display Studies

There has been, recently, concern that the use of CRT (VDT) display terminals in work settings may result in visio-ocular stress, musculo-skeletal stress, cataracts, and other health disorders (Dainoff et al. 1981, Smith et al. 1981, Zaret 1979, Sauter et al. 1983). While the results of most of these studies indicate that CRT (VDT) displays, themselves, do not have significant health or quality of working life consequences (Sauter et al. 1983, NAS 1983, AAO 1982), the studies do show differences in perceived task dimensions between users and non users [1]. For example, Smith et al. (1981), found that workers using CRT displays tended to have less autonomy and greater work pressure than those who worked without a system. No difference was found, however, in job satisfaction. Sauter et al., (1983) found significant negative differences between CRT (VDT) users

and a control group of non users on, among other task dimensions, job autonomy, work pressure, management control over workers, and physical comfort of the work place, but no difference in job satisfaction or affective disturbances (mood states).

The implication of these findings is that workers using CRT (VDT) displays have a poorer task environment than workers not using them, although these differences are not strong enough to influence well-being. Yet, if negative changes in task content do occur with the use of computer systems, this is an important finding that should not be over looked. It means that a poorer job is one consequence of the adaptation of computer technology. If this is a consistent pattern in a variety of situations, the reasons for these changes must be understood so that they can be avoided, if possible.

The consistent evidence of more generalized psychosomatic stress problems associated with the use of computer systems in work settings, based on self report data in a number of studies from several countries (Johansson and Aronsson 1980, Bradley 1977, Turner 1980, Smith et al. 1981), suggests that the difficulty may be more fundamental than just the specific form of the man-machine interface. The implication of this consistent evidence is that the issue may be stress resulting from the redesign of work that accompanies an

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[1] - Some caution is needed in interpreting the findings of the CRT (VDT) studies because of their relatively narrow focus on the form of system output and because they were not designed specifically to investigate changes in task environment. For example, in the Sauter (1983) study, the control group contained subjects that used application systems with other forms of a systems interface, e.g., typewriter terminal, key punch, etc., so that contrasts between users and non users of application systems (instead of contrasts between users and non users of CRT (VDT) displays) can not be made.

application system (Turner and Karasek 1984).

2.4 Summary

No clear pattern of results have emerged from the previous studies of the use of application systems in work settings. An equal number find negative results as do positive on any particular dimension of work. Most studies, however, find no significant differences in well-being. About the only consistent finding is that significant changes in tasks do result when jobs are redesigned to make use of computer systems. While there is some evidence that these changes are negative, it is not at all clear whether there are systematic patterns in the ways tasks are changed.

What might account for this failure to find consistent results in the prior studies? One answer may be that there are no patterns. The technology itself does not determine the outcome; it is how the technology is applied and each situation is different (a contingency view). This would not, however, explain the considerable evidence of psychosomatic stress or the consistent pattern in the research findings, in a wide variety of settings, of a poorer task environment and it is not helpful in understanding how specific outcomes occur.

Another reason may be that flaws in prior research have contributed to this confounding of results. The notion that technology operates on outcomes directly rather than through the mediating effects of the task may be one factor. This is part of the larger problem of not having an explicit model that can be used to represent the ways tasks change. This omission is not the only flaw,

however. Many of the studies referenced here have been criticized on methodological grounds, particularly for problems of control and failure to isolate treatment variables (Starr et al. 1982, Sauter et al. 1983). In many cases only one situation is investigated, or the number of subjects is so limited as to be statistically suspect. Few of the studies make use validated methods of concept measurement (with the exception of Smith et al. 1981 and Sauter et al. 1983) and most studies do not control for potentially confounding variables (e.g., the level of the job).

We are no closer to comprehending what occurs when computer technology is introduced into jobs than when Mann and Williams completed their study 24 years ago. Yet as our economy moves from producing goods to providing services it becomes critical to understand the interplay between technology and the well being of the labor force. As Simon observes,

> We need to be particularly thoughtful about the short run impacts of the installation of automatic systems in particular work places (1981, p. 72).

2.5 Research Approach

How might one go about investigating this question? Simon (1981) observes that, "you have to compare the clerk on the high stool with whatever job that clerk is performing now." Studies of human behavior and performance suggest that reactions to the use of computer technology will involve at least the following factors:

1. The type of task being performed. The consequences of using computer technology are likely to be different for

different tasks and job levels. In situations where use is mandated, for example, in routine clerical work, negative outcomes are likely to be pronounced. When use is optional, individuals experiencing poor outcomes probably will decide not to use a system. Continuous users should show stronger effects than intermittent ones.

2. The characteristics of the individual. Depending upon background, experience, training, skills and personality individuals are likely to respond differently to the use of computers.

3. The social setting of the job including norms of behavior and the saliency of information about past activities.

4. The task dimensions of the prior job. If the prior job was a poor one, for example, a single repetitive task with a completely specified procedure, then any change is likely to be an improvement. If the prior job had some variety and permitted choice in the selection of procedures and in their execution then the change could represent a deterioration. This factor is likely to be more important at change-over and less important over time.

5. The task dimensions of the changed job. The use of an application system in a job represents a change in the tasks performed and the procedures used to perform these tasks. Over the long term, this factor is likely to have the greatest effect on outcomes.

6. The process of implementation. Implementation of application systems can be thought of as brining about planned change in organizations (Ginzberg 1981). The strategies used for implementation, the alterations in power implied by a system, and the involvement of key actors in the process are likely to determine short run outcomes.

Any successful strategy for investigating the effects of computers on workers must confront these factors. One approach is to determine whether the large number of systems built to date have resulted in any systematic affects on workers. This would provide an indication as to whether there have been any consistent results in the application of computer systems in work settings that transcend the specifics of the situation [2].

The first step in a program to investigate consistent patterns would be to develop a model of task dimensions that include those that are expected to change when application systems are used in jobs and also are likely to influence well-being. Next, in order to strengthen controls that have been missing in previous efforts, study one job in detail. Enough subjects and settings should be used to control for individual and implementation differences as well as the characteristics of the prior job. Then, repeat this study for a number of different jobs to see if the results can be generalized. Finally, if a general pattern emerges, attempt to understand which job aspects are affected, why changes take place, and if changes are negative, what compensating strategies are available for system designers and managers.

3.0 MODEL

Two themes have dominated the study of work environments. The first, stemming from the investigations of Turner and Lawrence (1965), Hackman and Lawler (1971), and Hackman and Oldham (1976) uses job decision latitude as the primary linkage to job satisfaction and absenteeism. The second theme concentrates on the illness induced by job or environmental stressors (Dohrenwind and Dohrenwind 1974, Caplan et al. 1976, Theorell 1976).

Unfortunately, as Karasek (1979) observes, these research

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[2] - If no consistencies are found, a somewhat different question must be dealt with. Given a particular situation, what factors are likely to change with the introduction of a computer system? This suggests a diagnostic strategy. Although, if there are no general principles, this approach becomes ad hoc.

traditions have remained separate with the research on job decision latitude seldom including consideration of job demands, or the reverse, the job demands research rarely incorporating decision latitude. This separation has been reflected in the primary work environment measurement schemes, the Job Diagnostic Survey (Hackman and Oldham, 1976) and the Job Characteristics Inventory (Sims et al. 1976), both based on the decision latitude model, which do not include a measure of job demands [3]. Furthermore, the decision latitude model has tended to omit mental strain indicators (emotional exhaustion) as a dependent variable. Not including job demands or mental strain indicators in work measurement schemes robs designers of important task parameters that are needed for a more complete characterization of the task environment as well as ones they can control.

Another shortcoming of these measurement schemes is that they fail to capture either the degree of interaction between workers during task execution or the structural arrangements among workers that permit obtaining job related information. Not including interactions between workers or structure presents an unrealistically self centered view of task accomplishment. These deficiencies suggest the use of combinations of factors rather than one of the established

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[3] - The third generally used measurement scheme, the Measure of Perceived Work Environment or PWE (Newman 1977) contains measures of Task Characteristics - the extent to which the jobs/tasks are characterized by variety, challenge, worthwhile accomplishment, etc.; Decision Making Policy - the extent to which workers take part in decisions that affect their work situation; and Pressure to Produce - the extent to which there are pressures to produce. While in certain jobs, for example, those that are machine paced, pressure to produce may be strongly associated with work load, this measure will not capture work load in all situations.

schemes to represent the work environment for the purpose of understanding how the use of computer systems changes jobs.

3.1 Attributes Of The Work Environment

The decision to develop a computer application system implies changes in the content of tasks workers perform and in the structural arrangements among workers. That is, changes in the man-machine division of labor that occur during the design of an application system result in certain tasks being performed as programs (by a computer) while others are performed by an operator. After completion of the transient implementation process a steady state condition emerges with workers performing a new sequence of tasks, possibly some with new content.

Perceptions about the tasks performed as well as other factors (for example, individual differences, supervisory style, social context, performance-reward relationships, etc. as well as perceptions of valence and instrumentally of task attributes) influence an employee's intrinsic motivation. This, in turn affects the worker's emotional state, attitudes toward the job, and performance (Aldag and Brief 1979).

As Perrow (1967) observes, the nature of the raw materials or inputs to an organization and the processes (or technology) required to convert them into outputs affects how the organization is operated and structured. Computer technology, because it expands the ways in which a job can be organized and it has the potential to enhance a worker's abilities (for example, by assisting in the structuring of a

task or by serving as a source of reference information), tends to be viewed as facilitating (Griffin 1982). Yet, this is not necessarily the case. Technology also may be conceived as constraining, in that it limits the number of way a job can be designed (Oldham and Hackman 1980). It is the interplay between computer technology and the dimensions of the work environment that have escaped investigation (for exceptions, see Turner 1984).

3.2 Task Inpact Model

The current view of individual information processing is based heavily on the social interaction model of Salancik and Pfeffer (1978). The reactions of workers to tasks are seen to be related to the information available to them at the time they express their attitude or need. An important source of information is the person's immediate social environment (that is, co-workers, organizational norms, culture, etc.) which provides cues that individuals use to interpret and construct events. This information is also used by the individual in deciding what their attitudes and opinions should be. Thus, the social information processing perspective sees workers bound by their social context to behavior through a process of commitment. The affects of saliency of information about an individual's past activities provides norms and expectations that constrain their rationalization or justification of these activities.

While social interactions are one source of information that shape a worker's perceptions, another is the recollection of actual experiences encountered while performing a task. This is particularly true of workers in structured jobs, who tend to be constrained in

action by the cyclic nature of their work and the procedures they must follow. This ritual is a constant reminder of the knowledge (and skill) needed for task accomplishment as well as the problems with which they must contend.

Workers are conceived as open social systems that must deal with both external and internal work related uncertainty. That is, they must cope with the difference between the knowledge needed for task execution and the knowledge available to them. This uncertainty emanates from two sources: lack of knowledge about how to perform a task, and lack of knowledge about what to do when exception conditions arise (Perrow 1967). Exception conditions arise primarily from variations in input (e.g., the state of raw material or encountering some unexpected event).

If workers are to deal with these sources of work related uncertainty, a critical factor is their ability to obtain and interpret (that is, process) information that they do not possess (Galbraith 1973). Information can come from a number of sources including documentation, co-workers, and supervisors. A basic function of structure is, thus, to create work unit configurations, as well as the linkages among these units, that facilitate information flow.

Five factors contribute to task related uncertainty: the nature of the task, the condition of the inputs, the tools available to perform the task, the worker's experience and skill, and the structural arrangements among workers that govern information flow.

The perceived effort involved in task execution involves the interplay among at least five factors [4].

1. The subtask to be performed (e.g., calculation or data retrieval). This determines the specific transformations (i.e., the operations and the data to which the operations apply) that the operator actually invokes. These are a function of the content and level of the job.

2. The tools available to the operator for assisting in performing a subtask and the characteristics of these tools. These can alter the sequence and content of subtasks performed by the worker.

3. The degree of uncertainty with which the operator must cope.

4. The amount of work to be done. This is related to the load imposed by the execution of sub-tasks, the demand or backlog of work, and the extra load that results when exception conditions are encountered (Perrow 1967).

5. The degree of discretion allowed to an operator. This determines the extent to which different work methods and problem solving strategies can be applied and, ultimately, the operator's performance.

The interplay among these variables is mediated by the extent to which sub-tasks are self contained or interdependent. When workers must seek assistance from others, the specific structural arrangements among workers for exchanging information, the social context of the work environment, and the norms developed from past experience all influence the worker's perception of how much effort (and time) need be expended to obtain problem solving assistance (Salancik and Pfeffer 1978).

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[4] - Many more factors could have been used to describe the task environment, including variety, task identity, feedback, etc. Due to a practical limitation on the number of factors that can be represented and because other studies have found these variables to be highly intercorrelated, factors have been selected that are relatively independent and are likely also to be meaningful for system designers.

Job demands and job discretion, as well as the various structural factors have been shown to be associated, to varying degrees and with varying levels of consistency, with measures of job satisfaction, performance, absenteeism, emotional exhaustion, alienation, and many other variables (Aldag and Brief 1979, Hackman and Oldham 1980).

3.3 Task Impact Model

Diagram 1 shows the Task Impact model. Outcomes, such as job satisfaction, emotional exhaustion and productivity are influenced by the work environment, consisting of such task and structural factors as discretion, work load, problems, and interdependence. These, in turn, are effected by the characteristics and extent of application system use. That is, workers' attitudes and performance are a function of task characteristics and structural arrangements which are, in turn, a function of the characteristics and use of an application system.

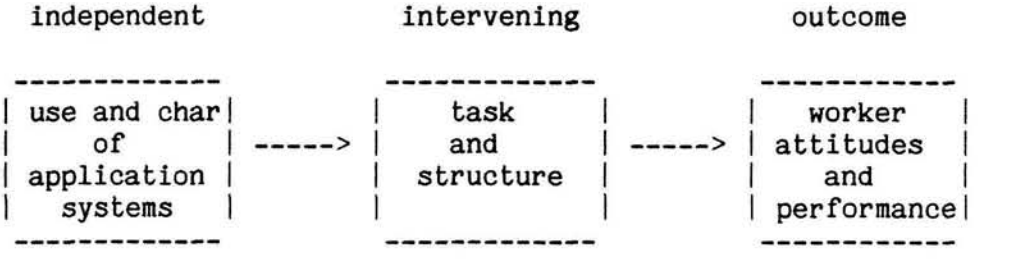

Diagram 1

Task Impact Model

The presence of an application system in a particular job results in a new human-machine division of labor and, consequently, a different set of tasks for the operator to perform. These tasks

involve different sequences of operations and pose new sets of problems for which the worker must cope. They also result in new interdependencies with co-workers and supervisors. This, in turn, creates a need for training and for the acquisition of new skills. It is in responding to this work environment that an operator experiences changes in job satisfaction or mental strain symptoms [5].

3.4 Methodological Issues

There are two additional issues that warrant discussion. As mentioned earlier, the current view of individual information processing rests heavily on the social interaction model of Salancik and Pfeffer (1978). Consequently, any attempt to assess task characteristics from self reports of incumbents must contend with the potential bias induced by the prevailing attitudes and culture of specific work settings. One strategy for coping with this problem is to include enough work groups in the sample so that any specific attitude may be considered to occur randomly.

Second, as Aldag, Barr, and Brief (1981) observe, there is some question as to whether perceived task characteristics are an accurate reflection of actual task content. However, we maintain that it is the worker's perceptions of the task environment that govern behavior, rather than the actual tasks performed.

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[5] - Other factors, such as changes in performance-reward relationships, supervisor style, social interactions, etc. are also likely to influence these outcomes.

3.5 Research Questions

The following research questions were investigated:

1. The use and characteristics of application systems do not influence outcomes directly. Changes in outcomes, if any, take place through changes in the work environment (that is, by changes in task and structure).

2. The patterns of change in task and structure will depend on the level of the job.

3. Changes in the work environment will tend to be negative for structured jobs.

4. Improvements in productivity will be associated with the use of application systems in structured jobs.

4.0 METHODS

The study consisted of a questionnaire survey of 1) workers in the mortgage loan servicing departments of the 100 largest Mutual Savings Banks in the United States, 2) workers in the financial investment departments of these banks, and 3) operations heads of these banks.

Banking is a good industry in which to investigate the consequences of using computer technology because a bank's production system is almost completely record keeping and data transfer. As a result, data processing can be considered a bank's core technology (Galbraith 73). Banks have the advantage, also, of providing roughly comparable products and services and, due to reporting and regulation requirements, have evolved a common terminology easing some of the difficulties of data collection.

Mutual Savings Banks differ from Savings and Loan Associations in that they are state chartered and deposit customers are treated as bank share holders. At the time of the study, 1979-80, there were 469 Mutual Savings Banks located mostly in the northeast, mid-atlantic, and mid-west (NAMSB 1978). The industry had been relatively stable for the prior five years and automation was not a labor issue.

Banks included in the study exhibited greater than a 15:1 range in size as measured by funds on deposit (NAMSB 1978). Small banks (having less than 120 in full time staff) were omitted from the population because of the likelihood that jobs would be combined, confounding the analysis and defeating the research design.

4.1 Subjects

The sample consisted of 1548 workers in mutual savings banks: 1282 were mortgage loan servicing workers, 73 were their first line managers, 131 were financial investment workers, and 62 were their first line managers.

Mortgage loan servicing, which was selected to be representative of routine clerical work, consists of setting up new mortgage accounts (initiation), posting payments to accounts, correspondence, responding to information requests, preparing reports, closing retired accounts, and disposing of mortgages under certain foreclosure or delinquency situations. Financial investment, chosen to be representative of a partially structured task (Ginzberg and Stohr 1982), involves managing the bank's equity, debt, and money market investments. This consists of periodically computing the value of the bank's portfolio; tracking

changes in the value of particular instruments, general economic indicators, and events that are likely to influence the markets; periodically determining the position of the bank and checking whether it conforms to various regulations; and making and settling trades.

The response rate was 78% for mortgage loan servicing groups and 70% for financial investment. A 58% rate was obtained from operations officers. Mortgage loan servicing groups ranged in size from 48 to 4 with a mean size of 19 full time workers. Financial investment groups had a range of 7 to 0 workers with a mean of 3 (in some banks the manager performed the investment function without a staff).

4.2 Measures

The questionnaire consisted of items designed to measure psychosocial factors of a job which represent potential stressors or stress moderators, job satisfaction, strain symptoms, and absenteeism. Constraints on the amount of time required to complete a questionnaire prevented standard measures from being applied. Instead, key questions that have loaded heavily on indices used in prior studies, were selected and modified to suite the bank situation. The questionnaire contained 49 questions and took about 10 minutes to complete.

The same questionnaire was used by all subjects. Supervisors in both groups received an additional cover sheet designed to measure the functions performed by their group, productivity, performance, group absenteeism, and average application system use. Operations heads were sent a separate questionnaire designed to measure the

characteristics of the bank's application systems, data processing costs, methods of obtaining resources, and bank performance.

The indices used in the study are described below:

1. Computer Use Intensity: Frequency with which an application system or output from a system is used in performing your job; extent to which others in your group use an application system in their job; contact with DP department (alpha = .66).

2. Application System Characteristics (a discussion of the reasons for the selection of these parameters and the methods of measurement can be found in Turner 1981):

a. system type: processing structure (batch to on-line); resources allocated to representative processing functions; system-user communication (one to two way) (alpha = .52).

b. technical complexity: number of modules; transactions per week; proportion of master file changed per week (alpha = .84)

c. organizational complexity: number of geographic locations use output; number of logical records (alpha = .79).

3. Job Discretion: make decisions about the time scheduling of work tasks; make decisions about how to organize work tasks; influence bank policies that effect work (alpha = .63) (McMahn and Ivancevich 1976, Karasek 1979, Hackman and Oldham 1975, Sims et al. 1976).

4. Task Demands: How heavy is the work load; how often face time pressure to get the work done; frequency of exceptions that require special handling; time spent resolving exceptions; how often face conflicting demands (alpha = .66) (Billings 1977, Buck 1972, Caplan et al. 1975, Insel and Moos 1974, Karasek 1979, Van de Ven 1976, Perrow 1967).

5. Task Interdependence: Depend on co-workers, supervisor, workers and supervisors outside of work unit in performing job; co-workers, supervisor, workers and supervisors outside of work unit dependent upon you (Lynch 1974, Van de Ven 1976, Pennings 1974, Sims et al. 1976).

6. Ease of Assistance: perception of the work group's communication effectiveness; how easy is it to obtain problem solving assistance from co-workers, supervisor, workers and supervisors outside of work unit (March and Simon 1958, Leavitt 1972, Sims et al. 1976).

7. Job Level: What level of skill in terms of formal education or training are necessary to perform job; how many years of banking experience are necessary to perform job; how repetitious is your job; do you need supervisors permission to leave job for 30 minutes (alpha = .70).

8. Opportunity to Use Skills: Does your job allow you to make use of all your skills and abilities (single item) (Sims et al. 1976).

9. Formalization: How much of your work is covered by written procedure or a rules manual; how much emphasis is placed on quantitative production records, such as the number of loans serviced in a day (single items) (Hage and Aiken 1969, Inkson et al. 1970).

10. Job Organization: The extent to which others in your work unit do the same job as you do (single item).

11. Size: Ranking, in terms of funds on deposit (single item).

12. Mental Strain Indicators: How often have difficulty rising and getting started in the morning; totally exhausted at end of the day; feel nervous, anxious, or jittery; difficulty sleeping (alpha = .64) (Seiler 1973, Karasek 1979, Maslach and Jackson 1981).

12. Job Satisfaction: The degree to which members of a social system have a positive orientation toward membership in the system; would you take this same job again; would you recommend this job to a friend (alpha = .78) (Quinn et al. 1973, Price 1972).

13. Absenteeism: The average number of sick days taken over the last year.

14. Productivity: The average number of loans serviced per worker over the past year; average portfolio value per worker (single items).

15. Performance: Number of complaints per month; proportion of loans 120 days in arrears; average yields on equities, bonds, and money market investments over past year; portfolio appreciation over past year.

The application system characteristics, productivity, and performance measures apply only at the aggregate level. All scales have internal consistency significant at the 0.1 level or better.

Questionnaires were completed as part of the regular work routine and placed in sealed envelopes to maintain confidentiality.

4.3 Analysis Of Data

Five sets of data analyses were performed:

1. Univariate Group Comparisons. The four job categories were compared on measures of perceived job characteristics and well being. Intense and non-intense users of application systems were compared for two job categories - mortgage loan servicing and financial investment workers - on measures of perceived job characteristics and well being.

2. Bivariate Associations. First order correlation coefficients were used to explore associations between measures of job characteristics and well being for two job categories - mortgage loan servicing and financial investment workers.

3. Correlates of Well Being. Job satisfaction, mental strain symptoms, and absenteeism were regressed, in three separate stepwise analyses, on four task variables, computer use intensity, and five control or situational variables.

4. Causal Analysis. Path analysis was performed for two job categories - mortgage loan servicing and financial investment workers.

5. Aggregate Analysis. The data on subjects was aggregated by work group (job within organization), and combined with data about group productivity, performance, and information systems characteristics. Univerate comparisons of intense and non-intense work group use of application systems and analysis of correlates of group satisfaction were performed.

5.0 RESULTS AND DISCUSSION

5.1 Univariate Comparisons

Table 1 compares task and well being factors for four job categories; mortgage loan servicing workers and supervisors, financial investment workers and managers. Based on measured job characteristics, mortgage loan servicing workers have the poorest of the four jobs, while financial investment managers have the best. It follows that mortgage loan servicing workers should score lowest on task characteristics that are usually strongly related to the level of the job and measures of well being, while financial investment managers should score highest. These relationships are found in the data, suggesting face validity. Mortgage loan servicing workers scored lowest on job level and discretion while financial investment managers scored highest.

	Sample Means			
	Mortgage Loan Servicing		Financial Investment	
Scales	Worker (N=1282)	Manager (N=73)	Worker (N=131)	Manager (N=62)
Task Factors				
Computer Use	3.28	3.28	2.45	2.24
Job Level	2.86	4.14	3.54	4.48
Job Interdependence	2.94	3.79	3.15	3.42
Task Demands	2.58	2.76	2.38	2.43
Job Discretion	3.11	4.34	3.59	4.55
Ease of Assistance	3.27	3.34	3.32	3.75
Well Being				
Mental Strain Ind.	2.78	2.42	2.40	2.27
Job Satisfaction	3.58	4.09	4.13	4.60
Absenteeism	2.60	1.81	2.27	2.06

indices scaled low to high

Group Comparisons for Task Factor and Well Being Scales

Table 1

As expected, mortgage loan servicing workers appear to have the poorest of the four jobs in that they scored lowest on job satisfaction, and highest on mental strain indicators and absenteeism. Financial investment managers scored highest on job satisfaction, lowest on mental strain indicators, and next to lowest on absenteeism. It is interesting to note that mortgage loan servicing supervisors and workers make the same amount of application system use while financial investment managers make less use of computer systems than do their workers.

Table 2 provides a comparison, for mortgage loan servicing workers, of intense and non-intense application system users on task characteristics and well being. Non-intense application system users do seem to have significantly different jobs than intense users, however the pattern is more complex than just being a poorer job. Non-intense users have less task demands (work load) and task interdependence, suggesting a better job, but, at the same time, less job discretion and less ease of assistance, indicating a poorer one.

Scales	Sample Means: Non-Intense Users (N=285)	Intense Users (N=633)
Task Factors		
Computer Use	1.79**	4.09
Job Level	2.78**	2.88
Job Interdependence	2.72**	3.09
Task Demands	2.39**	2.71
Job Discretion	2.90**	3.18
Ease of Assistance	3.12*	3.33
Well Being		
Mental Strain Ind.	2.72	2.84
Job Satisfaction	3.55	3.55
Absenteeism	2.55	2.60

** - p< .01 ANOVA
* - p< .05 ANOVA

Group Comparisons for Intense and Non-Intense Users
of Computer Systems - Mortgage Loan Servicing Workers

Table 2

Consistent with the results of prior studies, no difference is found between intense and non-intense users of computer systems on the three well being measures. When financial investment workers are subject to the same univariate analysis, no difference is found on either the task factors or the well being indicators, on the basis of computer use intensity.

Contrary to Zuboff (1982), this study finds intense computer users to have greater, rather than less, interdependence with other workers. Intense users, also, perceive that they have a job that requires a higher level of skill than less intense users.

In summary, face validity is indicated for the measures used in the study. Workers, in a structured job, do appear to have different task characteristics than workers making less intense use of the

system. No difference, however, is found in measures of well being. These findings do depend on the level of the job. Workers in a semi-structured job show no difference in task characteristics or well being on the basis of application use intensity.

5.2 Bivariate Analysis

Table 3 provides a comparison of the first order product moment correlation coefficients for mortgage loan servicing and financial investment workers. Computer use intensity, for mortgage loan servicing workers, is positively associated with job interdependence, task demands and job discretion, but is not associated with any of the well being measures. Computer use intensity is not associated with any task or well being measures for financial investment workers.

Scales	1	2	3	4	5	6	7	8	9
Task Factors									
1. Computer Use		.06	.10	.03	.16	.15	-.01	.04	.07
2. Job Level	.05		.12	.21 *	.40*	.07	-.13	.16	-.15
3. Job Interdep.	.14**	.19**		.13	.20	-.05	.01	-.02	.08
4. Task Demands	.18**	.20**	.28**		.08	-.18	.24*	-.06	-.12
5. Job Discretion	.11**	.46**	.09**	.11**		.16	-.10	.24*	.14
6. Ease of Assist.	.06	.04	-.13**	.06	.09**		-.37*	.40*	-.01
Well Being									
7. Mental Strain	.06	-.11**	.27**	.06	-.11**	-.13**		-.42*	.27*
8. Job Satisfact.	.01	.25**	-.11**	.01	.23**	.25**	-.30**		-.06
9. Absenteeism	-.01	-.11**	-.03	-.01	-.11**	-.08	.15**	-.15**	

lower triangular portion - mortgage loan servicing worker sample (N=1548)
upper triangular portion - financial investment worker sample (N=131)
** - p< .001 two tailed test
* - p< .01 two tailed test

Intercorrelations Among Study Measures for Mortgage Loan Servicing and Financial Investment Worker Samples

Table 3

The same general pattern between task and well being variables is found for both samples. Increased task demands and job discretion are associated with job level. Task demands are positively associated with indications of mental strain, while job discretion is positively associated with job satisfaction. Ease of assistance is negatively associated with mental strain indications and positively associated with job satisfaction. Mental strain and job satisfaction are negatively associated.

The results suggest that 1) these task dimensions are related to well being measures, 2) for a structured task, computer use is related to changes in task dimensions, and 3) that computer use is not directly related to measures of well being.

5.3 Correlates Of Well Being

Table 4 shows the results of an analysis in which the four task dimensions of the model and computer use intensity were regressed, in a stepwise procedure, on mental strain indicators for the complete sample. When the five exogenous (control) variables and job satisfaction are allowed to enter the regression (expanded model), 19% of the variation in mental strain symptoms is explained. The two largest contributors are task demands and job satisfaction (negative).

Regressor	Expanded Model Reg. Coef.	Expanded Model Std. Reg. Coef.	Expanded Model Partial Coef.	Original Model Reg. Coef.	Original Model Std. Reg. Coef.	Original Model Partial Coef.
Job Satisfaction	-.22	-.25	-.26	-	-	-
Task Demands	.31	.25	.26	.35	.28	.28
Job Level	-.12	-.10	-.09	-.21	-.17	-.14
Time in Prof.	-.05	-.08	-.08	-	-	-
Bank Size	-.00	-.06	-.07	-	-	-
Ease of Assist.	-.03	-.05	-.05	-.07	-.10	-.09
Interdependence	.04	.05	.05	-*	-	-
Job Discretion	-*	-	-	-.07	-.07	-.06
Computer Use	-*	-	-	-*	-	-
Time in Position	-*	-	-	-	-	-
Use Skill	-*	-	-	-	-	-
* - stepped out of model at 0.1 level						
df - 1555				df - 1555		
mult. R - .44				mult. R - .36		
adj. R sq. - .19				adj. R sq. - .13		

Regression of Mental Strain Indicators

Table 5

Table 5 shows the results of regressing the four task dimensions and computer use intensity on job satisfaction for the complete sample. Entering the five exogenous variables and mental strain indicators permits 28% of the variation in job satisfaction to be explained (expanded model). The largest contributors are opportunity to use skills, mental strain indicators (negative), ease of assistance, and job level. Interestingly, computer use intensity doesn't survive in either of the two models.

Regressor	Expanded Model Reg. Coef.	Std. Reg. Coef.	Partial Coef.	Original Model Reg. Coef.	Std. Reg. Coef.	Partial Coef.
Use Skills	.16	.24	.25	-	-	-
Mental Strain	-.24	-.21	-.23	-	-	-
Ease of Assist.	.13	.17	.19	.16	.21	.22
Job Level	.20	.15	.13	.36	.26	.23
Job Discretion	.12	.11	.11	.14	.13	.12
Task Demands	-.11	-.08	-.09	-.18	-.12	-.13
Interdependence	-*	-	-	-*	-	-
Computer Use	-*	-	-	-*	-	-
Bank Size	-*	-	-			
Time in Prof.	-*	-	-			
Time in Position	-*	-	-			
df - 1555				df - 1555		
mult. R - .53				mult. R - .43		
adj. R sq. - .28				adj. R sq. - .19		

* - stepped out of model at 0.1 level

Regression of Job Satisfaction

Table 6

5.4 Causal Analysis

In order to show interrelationships among computer use intensity, the other task dimensions and measures of well being, and to permit a comparison between the ways computer use influences different jobs, a path analysis was performed for mortgage loan servicing (diagram 2) and financial investment workers (diagram 3). Path analysis is a technique for identifying those variables that are potential determinants of the effects and then attempting to isolate the separate contribution to the effects made by each predictor variable (Asher 1976, Billings and Worten 1978).

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place diagram 2 about here

A time ordering or sequencing of variables is implied in path analysis. The decision to make use of a computer system in a structured job (i.e., to design an application system for the job) results in a redesign of the job with a new division of labor between operator and machine. In this restructured job, not only is the machine performing new tasks (i.e., requires that a new program be written), but so is the operator. New procedures must be mastered and new tasks learned. It is the operator's reaction to the new job that results in changes to outcome dimensions, such as emotional exhaustion, job satisfaction, productivity, and performance. It is reasoned that use of a computer system results in changes to the interdependence among workers, the demands of the task, and discretion that the worker has in performing the job. If structural arrangements have beed adopted that facilitate obtaining problem solving assistance, this mediates some of the effects on mental strain indicators and job satisfaction.

The path analysis shows that computer use does positively influence interdependence, job demands and discretion. Job demands appear to be the primary pathway between computer use and the outcomes, that is, mental strain indicators and job satisfaction. What might account for this finding? As Galbraith (1973) has argued,

the uncertainty of a task determines the number of exception conditions encountered during task execution. These exceptions influence the amount of work related information that must be processed.

When a worker does not possess the needed information to deal with the exception condition, the worker must either retrieve the solution from memory, engage in a search for a solution (March and Simon 1958), or disregard the exception. With a computer based system (as contrasted with manual procedures), the worker does not have the option of ignoring the exception. The system will either refuse to continue or reject the offending transaction. Consequently, the worker must obtain assistance from other workers or consult reference material. This results in increased worker interdependence.

Deadlines for assigned work, however, must still be met. For example, input transaction batches must be closed and reconciled prior to a processing run. Because of the inflexibility of an application system, a worker doesn't have time to seek assistance from others or to provide assistance to them. The time allocated to problem solving results in increased work load. In addition, since every transaction is validated, many more exception conditions are recognized with a computer system than when the task was performed manually.

In a manual system, procedures are established to handle the exception conditions that are discovered. When deadlines occur, mutual adjustments can be made among workers to resolve the situation. The effect is, because fewer exceptions are uncovered, the system is more flexible and because workers understand it better, a manual

system is perceived as being less stressful [6].

Interestingly, job discretion and ease of assistance appear to potentially compensate, to some extent, for the negative influence of job demands. Giving workers more decision making latitude over the tasks they perform, the sequence in which they perform these tasks and their problem solving strategies is one way to obtain better control over a job and to make more use of skills (Turner and Karasek 1984). Workers with control over their jobs will be better able to accommodate the assistance requests of others. Another strategy is to change the structural arrangements among workers and the accepted norms of worker behavior to encourage the giving of problem solving assistance.

The path coefficients, although significant, are sufficiently small not to provide much influence on outcomes. For example, a one standard deviation change in computer use intensity only produces an 18% standard deviation increase in workload, which in turn produces about a 5% standard deviation increase in mental strain indicators and a 3% standard deviation decrease in job satisfaction.

Diagram 3 shows the path analysis for financial investment workers. Unlike the previous analysis, computer use does not influence any of the task variables, except for ease of assistance. It is reasoned that workers, adversely affected by using a computer (for example, one that doesn't know how to type, doesn't wish to learn how to use an application system, etc.) will not use it. Clearly, the model for this semi-structured job is a different one than for the

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[6] - Clearly, there are advantages for an organization in recognizing and correcting errors.

structured job; computer use plays a much less central role. The same general pattern, however, is found among outcome and task variables as with mortgage loan servicing workers. That is, mental strain indicators is negatively related to job satisfaction, ease of assistance is positively related to job satisfaction and negatively related to strain indicators, job discretion is positively related to job satisfaction, and task demands is negatively related to ease of assistance.

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place diagram 3 about here

To summarize the findings for individual workers:

1. In a structured job, workers making intense use of application systems do appear to have different task characteristics than do workers making less intense use of systems. That is, there does appear to be a systematic negative effect, although this interaction is complex.

2. In this job, tasks appear to become more interdependent and the demands of the job become greater for workers making more intense use of application systems. At the same time, workers perceive that they have more decision making latitude and that it is easier to obtain assistance from others.

3. Although some task dimensions do become more negative (i.e., interdependence and task demands increase) the changes are not sufficient, on the average, to result in significant changes to outcomes.

4. Computer use does not appear to influence outcomes directly. Any effects that occur are through the mediating changes in task dimensions.

5. The data suggest that by providing workers with more job

discretion and by adopting structural arrangements that make it easier to obtain problem solving assistance it may be possible to compensate for negative changes in task dimensions.

6. For a semi-structured job, computer use is not found to be directly associated either with changes in task dimensions (except for ease of assistance) or outcomes.

5.5 Aggregate Analysis

Because of differences in strategies for the division of labor among workers (that is, workers with the same job may not be performing the same tasks) it is difficult to compare productivity or performance of individual workers. In a similar manner, since the characteristics of data processing systems tend not to be customized for individual workers, it is more appropriate to investigate the interplay between these characteristics, and the productivity and performance of workers at the group (aggregate) level.

Individual scores on a parameter were aggregated for each job to provide a new statistic, the measure of central tendency of the parameter for the work group. As Cronbach (1976) observes, a variable at different levels of analysis is actually a different variable. Consequently, the model at the aggregate level is not the same as it is at the individual level.

Using the Mann-Whitney U test, a relationship ($n=70, p<.001$) is found between group productivity and group use of computer systems. When the association is controlled for organization size, its strength increases from $r=.27$ to $r=.53$ suggesting that the relationship is stronger than indicated. No difference is found when the productivity

relationship is controlled for work group size.

In terms of quality, a moderate negative association ($r=-.17$, $p<.09$, $n=68$) was found between loan delinquency rate and group intensity of computer use. One could speculate that more accurate account status information, more easily obtainable, leads to better follow-up on overdue accounts. For financial investment work groups, no statistically significant relationship was found between measures of performance or productivity and group intensity of computer use.

The data provide good support for the notion that, in structured tasks, increases in labor productivity are associated with more intense use of computer systems. This finding is consistent with Melman's (1956) observation that machines are substituted for labor based on the relative cost of each. Since the unit costs of computing have been falling relative to those of labor, it is not surprising that in situations where computers have been substituted for labor greater productivity results. This result is also consistent with Katzell et al. (1977) review of 108 worker productivity studies that showed changes in socio-technical systems being associated with cost reductions in 8 out of 9 cases and product quality improvements in 8 out of 10 cases.

While it is intuitively obvious that productivity, performance and the characteristics of application systems used should be related, this has not been shown in previous studies. For the structured task, work groups using application systems with continuous (i.e., batch) organizations were more productive than groups using discrete (i.e.,interactive) processing organizations ($p<.04$, $n=27$, ANOVA).

Groups using continuous processing organizations that were more comprehensive (that is, with more functions, larger, etc.) were the most productive while groups using discrete processing organizations that were less comprehensive were the least productive. Groups using continuous processing organizations had higher levels of group task demands than did groups using discrete organizations ($p<.004$, $n=24$, ANOVA).

It is reasonable that, for a structured job, that work organized in a continuous manner would be more productive than work organized as a discrete process. Division of labor principles can be used to create jobs that are highly specialized with workers doing only a small, repetitive portion of the larger job. Continuous process systems take advantage of the natural sequence of processing to reduce overhead. While this approach may increase productivity over jobs with less specialization, it does so at a price. Workers have a less complete job and, consequently, perceive that they have less control over their job. Discrete systems permit the design of more complete jobs with the system providing support for user tasks. This notion is supported by Bjorn-Andersen (1976) who found, in a study of clerks in Danish banks, that those using a batch system reported a net decrease in task variety while clerks using an on-line system reported a net increase in variety.

Briefly summarizing the aggregate level results, it has been shown that:

1. For a structured job, groups making greater use of application systems have more productivity than groups making less use of these systems.

2. Groups using systems with continuous (batch) work organizations are more productive than groups using discrete (interactive) organizations.

3. Groups using continuous work organizations have more stressful jobs than groups using discrete organizations.

4. For a semi-structured job, no statistically significant relationships were found among application system characteristics and productivity or performance or group work environment.

6.0 IMPLICATIONS

It is significant that no relationships were found for the semi-structured job. At least two explanations are possible. Since system use is discretionary at this level workers adversely affected are unlikely to use it. Then, many factors contribute to portfolio performance including general economic conditions, the skill of the manager, and the mix of holdings. Improved information or the structuring of a problem that comes from an application system plays only a small part.

The results of this study indicate that workers, in a structured job, making more intense use of application systems have a somewhat poorer work environment than operators making less use of these systems. The poorer job comes about in two ways. Using an application system appears to increase work load and pressure, as perceived by workers. Then, increased interdependence among operators reduces the time available for one's own work, further increasing work load and time pressure. Together these two factors result in increased strain symptoms and decreased job satisfaction. Complicating matters, job discretion and ease of assistance are also

increased, mitigating somewhat the increase in strain symptoms and decrease in job satisfaction.

Using an application system in this job, however, also makes workers more productive. Furthermore, productivity and quality of the work environment are interrelated with the characteristics of the system. Not only is it the use a system in a work setting, but also the interaction between the structure of the system and the details of the task the operator performs that determines outcomes.

Organizational decision makers invest in application systems on the expectation of increased productivity. In the past productivity and working life quality have been considered independently. It is in demonstrating the competing nature of these two factors in the design of application systems that this research makes an important contribution. Designers of information systems must find a compromise between those aspects of a system that influence system efficiency and those that effect the quality of the job (Turner and Karasek 1984)

Considering the different populations studied, the variation in methodologies and methods used, it is remarkable that all studies of the use of computer systems in routine work have indicated that a poorer job results (Smith et al. 1981, Sauter et al. 1983, Kraemer and Dutton 1982, Zuboff 1982). Why is it that this occurs? Two factors likely contribute. First, the costs of efficiency are paid by management while the costs of work life quality are paid by workers. In this country (in contrast to Europe), decisions concerning trade-offs between efficiency and work life quality are controlled by management. Thus, to the extent that trade-offs are needed, it is

reasonable, although short sighted, to expect that decisions based on efficiency as the primary objective will predominate.

Second, major application system design decisions are often made by technical specialists, with users and management playing a less important role. Technical specialists, if left alone, tend to be guided by objectives of machine efficiency or implementation ease. Part of this undoubtedly has to do with designers reward structure. Minimization of machine resources tends to be a frequently cited criteria for system design (Lucas 1978). Part of it has to do with technical specialists preference for deterministic problems and a dislike for the ambiguity and uncertainty involved in dealing with people. Part also has to do with the application designer's lack of exposure to principles of work design. Most application system designers in this country have neither formal training in job design or first hand experience in the management of line operations. Consequently, job design issues tend to be neglected. Often, too, the change in work roles and structure that occur with application systems are not planned; they just are the result of the design of the machine portion of the system (Bjorn-Andersen and Jappe 1978).

The most important decisions made during the design of an application system concerning jobs are its processing organization, the complexity of the technology used to build the system and its boundaries [7]. These decisions are often made independent of any effect they might have on the work environment. As the designer of one large application system put it:

> We designed the system to process a bet efficiently. We didn't consider the clerks in the cage. When we brought it

> up they couldn't use the system and we had to redesign it. (Liebowitz 1980, designer of the NY Off-Track Betting System.)

As the limits of direct compensation are reached in many labor categories, improving the quality of working life may become increasingly more important as a means of indirect compensation. The results of this study suggest that, for this routine clerical job, organizational decision makers are missing an opportunity to improve the quality of the work environment at little or no additional cost. Since the use of an application system implies task changes, it seems a pity not to take advantage of the opportunity to create a new job with improved content. At the time application systems are implemented, they could just as easily be designed to produce favorable worker reactions as the negative ones suggested by the results of this study.

6.1 Compensating Strategies

What can be done to counter the tendency of designers of application systems to create poorer work environments for structured jobs? First, the results of this study suggest that by creating jobs with more decision latitude some of the undesirable effects of

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[7] - More specifically, whether the processing organization (or work flow) is continuous (batch) or discrete (interactive); the size and complexity of the system, which is partially determined by the techniques used for building the system (whether it is built on top of another system, such as a data base management system); and the alignment between the boundaries of the application system and those of the organization (whether it crosses departmental lines). For a more detailed discussion of the parameters of application systems and how they influence job design see Turner and Karasek (1984).

increased work load and pressure can be mitigated. In more complex work situations a major parameter of effectiveness is found to be the operator's freedom in selecting a response strategy (Sperandio 1971). A dynamic view of complex task performance emphasizes the importance of learning new skills (Turner and Karasek 1984). Because of the relatively low level of decision latitude in most jobs, opportunities to exercise judgement in work situations are usually viewed as a benefit.

The findings also suggest that providing workers with structural arrangements that facilitate problem solving will contribute to improved well being. When a worker is under deadline pressure to produce and a problem arises, lack of easily obtainable assistance leads to frustration. The current level of technology in application system design does not permit the building of an effective assistance providing mechanisms within the system [8]. If a worker must wait to see a supervisor or can seek assistance from only the supervisor, then this arrangement impedes task accomplishment.

Second, implementing application systems for structured jobs should be conceived as an opportunity to redesign work rather than burden to be avoided. The redesign of work and the rearrangement of structure, rather than the technology, should be the central feature of a new system.

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[8] - 'Help' facilities, the way that assistance is provided in most application systems, require considerable knowledge of the system in order to be used (e.g., keywords - the words used to index the material of interest). These facilities are also hierarchical, so that the user must traverse the data structure from root to leaf in order to find the needed material.

Third, technical specialists must become more aware of the implications their design decisions have for workers. We speculate that the negative impacts come from three classes of design issues: inflexibility in the application system, designs that do not take into account the operator's cognitive model of the system under control, and poor dialogue design (Turner and Karasek 1984). The solution is not more user training, or better documentation, or even more technical specialist training. It is, rather, to increase the understanding of how workers perform their jobs, the cognitive models they use to interpret and control a machine system, and the aspects of systems that produce these negative effects.

Organizational decision makers must acknowledge that the development of application systems that meet both human and technical needs involve compromise. Understanding the nature of these trade-offs and setting reasonable expectations for their resolution will go a long way in producing balanced systems. This study has suggested a number of trade-offs: between intensity of system use and productivity, between processing structure and task variables, and between intensity of use and task variables. Once these and other trade-offs are recognized, the challenge is to find operating points, in each situation, that provide for both productivity and working life quality.

6.2 Consequences Of No Action

What are the consequences of a poor work environment? Studies of concentrated stress and coping during extended overtime periods indicate that the adrenaline level of subjects was continually

elevated during the overtime period (Rissler and Elgerot 1979). A more important finding of this study was that subjects had pronounced elevation of adrenaline output in the evenings, which were spent relaxing at home. This was accompanied by elevated heart rate as well as feelings of irritability and fatigue. Frankenhauser (1978) has speculated that the effects of work overload may spread to leisure hours and may accumulate gradually. There is also evidence linking work load stressors to increased coronary heart disease (Karasek et al. 1980, Lunberg 1978). A recent study found heart disease to be more common among women clerical workers than professional women or housewives (Haynes et al. 1980).

One result of continued exposure to a low discretion and a low demand task may be a form of 'negative learning'. Individuals may lose their ability to solve problems and to make judgements if there is long term adaptation to these working conditions (Karasek 1979).

There is considerable evidence linking psychological pressures on the individual and job satisfaction (for example, Caplan et al. 1975). There has been the suggestion that job satisfaction could be an important factor in violent behavior (Mankin, 1978) and in drug use for men who were over 30 years of age (Quinn et al. 1974). Palamore (1969) has identified job satisfaction as the best predictor of longevity.

6.3 Macro Impacts

It is difficult to relate the results of this study to the broader question of patterns of future employment. The finding of increased productivity with the use of application systems in the structured job is consistent with the low employment and high productivity growth that has occured in many segments of the office industry over the 1970s and the general decline in back office occupations (Drennan 1983). To date, these dislocations have been more than offset by general growth in office work in the service sector and by jobs in information systems. Furthermore, the relatively small change in work environment suggests that alteration in job content associated with the use of computer systems is not radical. Consequently, with proper training, large segments of the working population should be able to master computer assisted jobs.

7.0 CONCLUSION

This study has explored the consequences of the use of computer application systems in office work. It has been argued that the consistent evidence of psychosomatic stress problems associated with the use of application systems may be the result of the redesign of work stemming from the implementation of the system. Evidence has been presented that workers, in a structured job, making more intense use of computer systems do have a poorer job than those making less use of systems. This occurs because the job tends to be more interdependent and involves greater demands. It has also been shown that productivity is increased with the use of application systems and that the work environment is influenced by the characteristics of

these systems.

A number of compromises in both the design of application systems and in the design of work have been identified. Various strategies for countering negative changes have been suggested including providing workers with more decision latitude in the selection of work methods and making it easier to obtain problem solving assistance. One thing is quite evident. The patterns of effects are quite different for jobs with different content. This suggests that future research should carefully control for the level of the job. It also underlines the need to assess a situation using some form of measurement instrument before deciding on an intervention strategy.

The results of this research are consistent with current thought in organization theory and working life quality. As Hedberg (1978) observes, people and human needs should be the starting point for designing computer based application systems. These systems should have implications for the technology rather than the reverse.

Bibliography

Aldag, Ramon J. and Arthur P. Brief 1979, Task Design and Employee Motivation, Glenview: Scott Foresman.

American Academy of Ophthalmology 1982, "Video display terminals (VDTs) and the eye," San Francisco, Ca.

Asher, Herbert B. 1976, Causal Modeling, Beverly Hills: Sage.

Billings, Robert S., Richard J. Klimoski and James A. Breaugh 1977, "The impact of a change in technology on job characteristics: a qusi- experiment." ASQ, 22(2): 318-339.

Billings, Robert S. and Steve P. Worten 1978, "Use of path analysis in industrial/organizational psychology: criticisms and suggestions." Journal of Applied Psychology, 63(6): 677-688.

Bjorn-Andersen, Niels 1976, "Organizational aspects of system design." Data, 12: 75-80.

Bjorn-Andersen, Niels and L. Jappe 1978, "Computer impact and the demand for participation." International Federation of Automatic Control Congress Proceedings, : 1183-1188.

Bradley, Gunilla 1977, "Computerization and some psychological factors in the work environment." in Reducing Occupational Stress, Washington: U. S. Department of Health, Education, and Welfare (NIOSH).

Buck, Vernon E. 1972, Working Under Pressure, New York: Crane Russak.

Caplan, R. D., S. Cobb, J. R. P. French, R. Van Harrison and S. R. Pineau, Jr. 1976, "Job demands and worker health: main effects and occupational differences." No.75-160, Washington: U. S. Department of Health, Education and Welfare (NIOSH).

Cronbach, Lee 1976, "Research on classrooms and schools: formulation of questions, design and analysis." unpublished paper, Stanford Evaluation Consortium, School of Education, Stanford University.

Dainoff, M. J., A. Happ and P. Crane 1981, "Visual fatigue and occupational stress in VDT operators." Human Factors, 23(4): 421-437.

Drennan, Matthew P., 1983, "Implications of computer and communications technology for less skilled service employment opportunities." final report, United States Department of Labor

grant number USDL 21-36-80-31.

Dohrenwend, Barbara S. and Bruce P. Dohrenwend 1974, Stressful Life Events: Their Nature and Effects, New York: Wiley.

Frakenhaeuser, Marianne 1978, "Psychoneuroendocrine approaches to the study of stressful person-environment transactions." in H. Selye (ed.) Selye's Guide to Stress Research.

Galbraith, Jay 1973, Designing Complex Organizations, Reading: Addison-Wesley.

Ginzberg, Michael J. 1981, "Early diagnosis of MIS implementation failure: promising results and unanswered questions." Management Science, 27(4): 459-478.

Ginzberg, Michael J. and Edward A. Stohr 1982, "Decision support systems: issues and perspectives." in M. Ginzberg, W. Reitman, and E. Stohr (eds.) Decision Support Systems, North Holland.

Griffin, Ricky W. 1983, Task Design, Glenview: Scott, Foresman.

Hackman, J. Richard and Edward E. Lawler 1971, "Employees reactions to job characteristics." Journal of Applied Psychology Monograph, 55(3): 259-286.

Hackman, J. Richard and Gregg R. Oldham 1976, "Motivation through the design of work: Test of a theory." Organizational Behavior and Human Performance 16: 250-279.

Hackman, J. Richard and Gregg R. Oldham 1980, Work Redesign, Reading: Addison-Wesley.

Hage, Jerald and Michael Aiken 1969, "Routine technology, social structure, and organizational goals." Administrative Science Quarterly, 14(3): 366-376.

Hardin, Einar 1960, "Computer automation, work environment, and employee satisfaction: A case study." Industrial and Labor Relations Review, 13(4): 557-567.

Hardin, Einar 1960a, "The reactions of employees to office automation." Monthly Labor Review, 83: 925-932.

Haynes, Suzanne G., and Manning Feinlieb 1980, "Women, work and coronary heart disease: Prospective findings in the Framingham heart study." American Journal of Public Health, 70(2): 133.

Hedberg, Bo 1978, "Using computerized information systems to design better organizations." Copenhagen Conference on Computer Impact, October 25-27.

Hoos, Ida 1961, Automation in the Office, Washington: Public Affairs Press.

Inkson, J., D. Pugh and D. J. Hickson 1970, "Organization context and structure: An abbreviated replication." Administrative Science Quarterly, 15(3): 318-329.

Insel, P., and R. Moos 1974, Work Environment Scales - Form S, Palo Alto: Consulting Psychologist Press.

Johansson, G. and G. Aronsson 1980, "Stress reactions in computerized administrative work." Supplement 50, Reports from the Department of Psychology, Stockholm University.

Krarmer, Kenneth L., and James N. Danziger 1982, "Computers and control in the work environment." paper prepared for the annual meeting of the American Sociological Association, PPRO, University of California at Irvine.

Karasek, Robert A. 1979, "Job demands, job decision latitude, and mental strain: Implications for job redesign." Administrative Science Quarterly, 24(2): 285-308.

Karasek, R. A., D. Baker, F. Marxer, A. Ahlbom and T. Theorell 1980, "Job decision latitude, job demands and cardiovascular disease: A prospective study of Swedish men." American Journal of Public Health, 71: 694-705.

Katzell, R. A., P. Beinstock and P. Faerstein 1977, A Guide to Worker Productivity Experiments in the United States 1971-75, New York: NYU Press.

Leavitt, Harold J. 1972, Managerial Psychology, Chicago: University of Chicago Press.

Lee, Hak Chong 1965, "Electronic data processing and employee perception of changes in work skill requirements and work characteristics." Personnel Journal, 44(7): 49-53.

Lee, Hak Chong 1965a, "Do workers really want flexibility on the job?" Personnel, 42 (March-April): 74-77.

Liebowitz, Burt 1980, personal correspondence.

Lucas, Henry C. 1978, Information Systems Concepts for Management, New York: McGraw Hill.

Lunberg, Ulf 1978, "Psychophysiological aspects of performance and adjustment to stress." in H. Krohne and L. Laux (eds.) Achievement, Stress and Anxiety.

Lynch, Beverly P. 1974, "An empirical assesment of Perrow's technology construct." Administrative Science Quarterly, 16: 338-356.

Mankin, Don 1978, Toward a Post-Industrial Psychology, New York: John Wiley and Sons.

Mann, Floyd C. and Lawrence K. Williams 1960, "Observations on the

dynamics of a change to electronic data processing equipment." Administrative Science Quarterly 5: 217-276.

March, James G., and Herbert A. Simon 1958, Organizations New York: John Wiley and Sons.

Maslach, Christina, and Susan E. Jackson 1981, "The measurement of experienced burnout." Journal of Occupational Behaviour, 2: 99-113.

McMahn, J. Timothy, and John M. Ivancevich 1976, "A study of control in a manufacturing organization: Managers and non-managers." Administrative Science Quarterly, 21(1): 66-83.

Melman, Seymour 1956, Dynamic Factors in Industrial Productivity, Oxford: Basil Blackwell.

Meyer, Marshall 1968, "Automation and bureaucratic structure." American Journal of Sociology, 73(3): 256-264.

National Academy of Sciences 1983, Vidio Displays, Work, and Vision, Washington: NAS Press.

National Association of Mutual Savings Banks 1978, National Fact Book of Mutual Savings Banks, New York: NAMSB.

Newman, John E. 1977, "Development of a measure of perceived work environment (PWE)." Academy of Management Journal, 20(4): 520-534.

Nussbaum, Karen 1983, "Office high tech is not here for good." In These Times, May 20-30: 12.

Oldham, Gregg R. and J. Richard Hackman 1980, "Work design in the organizational context." in B. Shaw and L. Cummings (eds.), Research in Organizational Behavior (vol. 2), Greenwich: JAI Press.

Palamore, E. 1969, "Predicting longevity: A follow-up controlling for age." Gerontologist, 9: 247-250.

Pennings, Johannes 1974, "Interdependence and complementarity." paper presented at the American Sociological Association annual conference, Montreal.

Perrow, Charles 1967, "A framework for comparative analysis of organizations." American Sociological Review, 32(2): 194-208.

Price, James L. 1972, Handbook of Organizational Measurement, Lexington: Heath.

Quinn, R. P., T. Magione and S. Seashore 1973, Quality of Employment Survey (Codebook), Ann Arbor: University of Michigan.

Quinn, R. P., G. Staines and M. McCullough 1974, Job Satisfaction: Is

there a Trend?, USDOL Manpower Research Monograph 30, Washington: USGPO.

Rissler, A. and A. Elgerot 1979, "Effects of work overload." as cited in Frankenhauser 1978, "Psychoneuroendocrine approaches to the study of stressful person-environment transactions."

Salancik, Gerald R., and Jeffery Pfeffer 1978, "A social information processing approach to job attitudes and task design." Administrative Science Quarterly, 23(2): 224-253.

Sauter, S. L., M. Gottlieb, K. Jones, V. Dodson and K. Rohrer 1983, "Job and health implications of VDT use: initial results of the Wisconsin-NIOSH study." Communications of the ACM, 26(4): 284-294.

Seiler, L., 1973, "The 22 item scale used in field studies of mental illness: A question of method, a question of substance, and a question of theory." Journal of Health and Social Behavior, 14: 252-264.

Shepard, Jon M. 1971, Automation and Alienation, Cambridge: MIT Press.

Simon, Herbert J. 1981, "Prometheus of pandora: the infulence of automation on society." IEEE Computer, 14(11): 69-74.

Sims, H. P., A. Szilagyi and R. Keller 1976, "The measurement of job characteristics." Academy of Management Journal, 19: 195-212.

Smith, M. J., B. Cohen, L. Stammerjohn and A. Happ 1981, "An investigation of health complaints and job stress in video display operations." Human Factors, 23(4): 387-400.

Sperandio, J., 1971, "Variation of operator's strategies and regulating effects on workload." Ergonomics, 14: 571-577.

Stanley, Amy Dru 1983, "High-tech will hurt women," NY Times, Op-Ed, September 19, 1983.

Starr, S. J., C. Thompson and S. Shute 1982, "Effects of video display terminals on telephone operators." Bell Laboratories internal report.

Theorell, Tores 1976, "Selected illnesses and somatic factors in relation to two psychological stress indices: A prospective study on middle aged construction workers." American Sociological Review, 41: 338-360.

Turner, A. N. and P. Lawrence 1965, Industrial Jobs and the Worker, Cambridge: Harvard Graduate School of Business.

Turner, Jon A. 1980, "Computers in bank clerical functions: Implications for productivity and the quality of working life." Ph.D. dissertation, Columbia University.

Turner, Jon A. 1981, "A method for measuring some properties of information systems." Proceedings of the Conference on Information Systems :259-275.

Turner, Jon A. and Robert A. Karasek, Jr. 1984, "Software ergonomics: effects of computer application design parameters on operator task performance and health." Ergonomics, 27, 6:

Turner, Jon A. 1984, "Computer mediated work: The interplay between technology and structured jobs." Communications of the ACM, 27, 12: 1210-1217.

Van de Ven, Andrew H. 1976, "Equally efficient structural variations within organizations." in Killmann, Pondy and Slevin (eds.), The Management of Organization Design: Research and Methodology, (vol. II), New York: Elserier.

Whistler, Thomas L. 1970, The Impact of Computers on Organizations, Cleveland: Case Western Reserve.

Zaret, M. 1979, "Cataracts following use of cathode ray tube displays." Proceedings of International Symposium of Electromagnetic Waves in Biology, France, June.

Zuboff, Shoshana 1982, "New worlds of computer-mediated work," Harvard Business Review, Sept-Oct: 142-152.

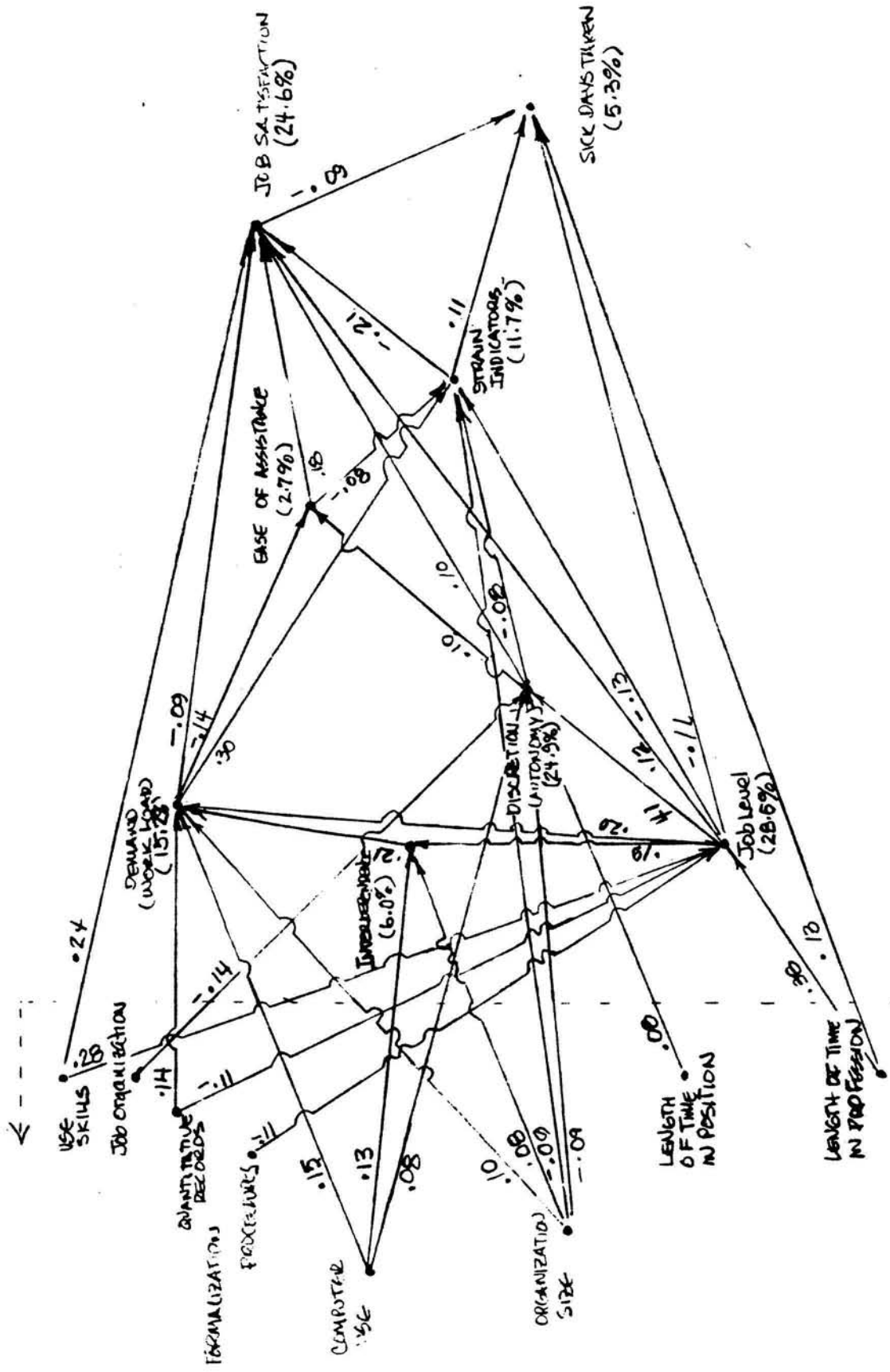

DIAGRAM 1

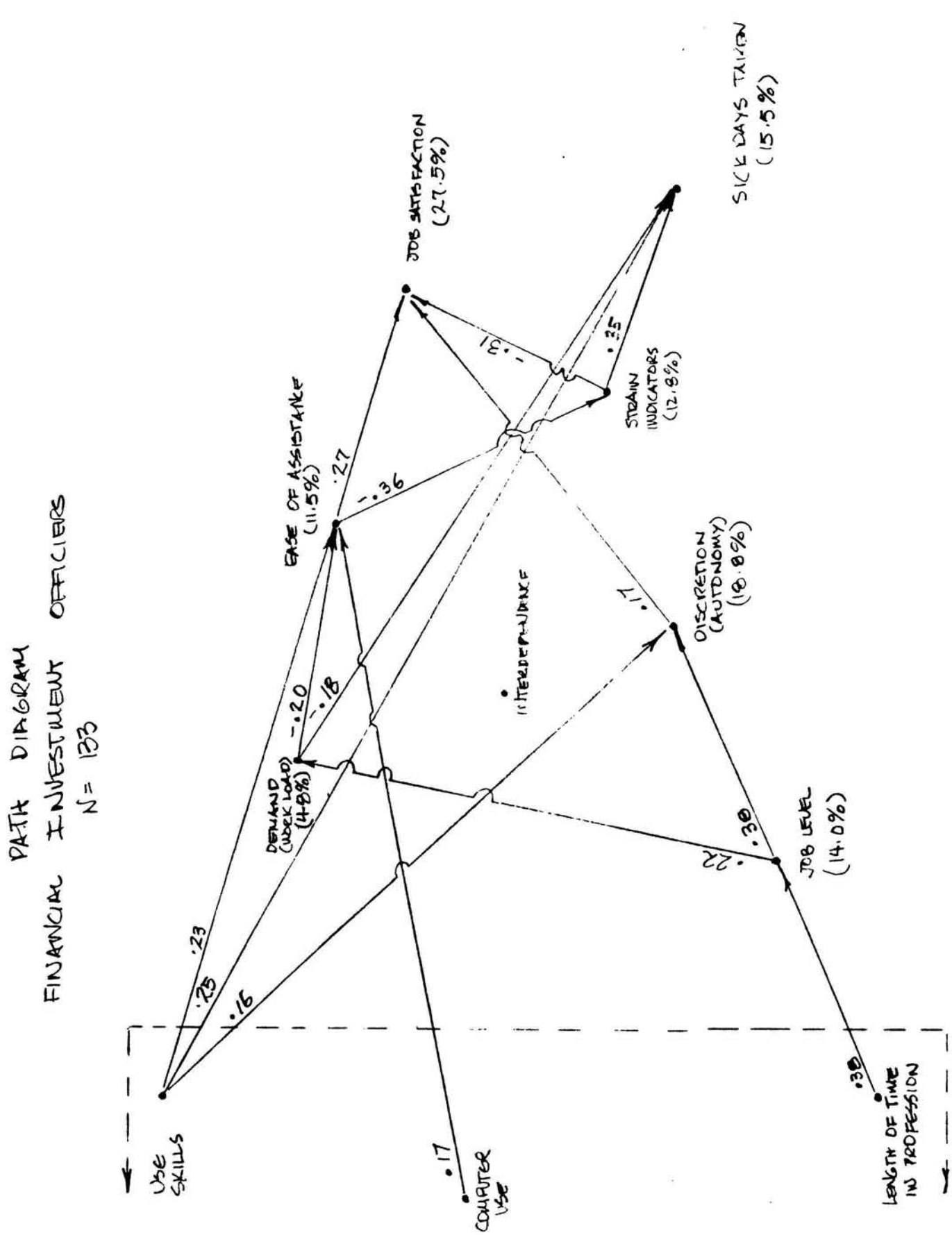

DIAGRAM 2