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ABSTRACT

The prevalence of end-user computing has resulted in a need for more effective methods of controlling such computing activities. The present experiment examined the impact of two potential control strategies, behavior-based and outcome-based control, on end-user affective reactions. Results indicated that subjects in the behavior-based control condition reported greater levels of stress, less self-determination, and less process satisfaction than the outcome control group. Further analysis suggested that the detrimental effect of behavior-based control on process satisfaction could be explained through the mediating effect of stress. Implications of the results for the design of effective end-user control strategies are discussed.

INTRODUCTION

End-user computing (EUC) refers to the capability of users to have direct control of their own computing needs (Davis & Olson, 1985) including the capability to develop their own applications. These applications may be solely created by the end user or through the assistance of others (data processing professionals or other users). End-user computing is one of the most important recent developments in corporate computing environments. It is a rapidly expanding phenomenon and is of growing strategic importance to many corporations (Benson, 1983; *EDP Analyzer,* 1983; Gritty & Rockart, 1984), and it is estimated that four out of five administrative and professional workers will be directly applying computing tools to support their work by 1990 (Davis & Olson, 1985).

Potential benefits attributed to EUC include enhanced productivity, overcoming the shortage of data processing professionals, ease of use and responsiveness, and overcoming implementation problems by transferring this process to the end user (Alavi and Weiss, 1985-86; Davis and Olson, 1985). These potential benefits and the improvements in the performance/price ratios of computer hardware and software have been the driving force behind the EUC activities in organizations. Despite its potential benefits and the general enthusiasm for end-user computing activities, there is a growing concern about the organizational risks and cost of these activities (Alavi and Weiss, 1985-86; Davis and Olson, 1985). Consider the following vignettes:

In a large electronics company about half of the corporate computer resources were being consumed by managers and staff who were developing and operating their own applications. Projection for support of EUC activities were comparable to the cost of an additional large mainframe computer every six months! Senior management became very concerned abut the computing expenditures in this area and demanded more controls and reassurance that the high EUC costs were, in fact, resulting in comparable benefits (Henderson and Treacy, 1986).

Using a spreadsheet software, a California executive recently predicted $55 million in sales over the first two years for a computer his company planned to introduce. Based on this projection, other managers began making plans for hiring additional staff and expanding inventories. Unfortunately, the sales projections were wrong because the executive had forgotten to include a price discount planned for a key component. Upon closer examination of the software, it was discovered the sales estimate was inflated by $8 million because his pricing formula was wrong (*Business Week,* 1985).

In a utility company, end users used spreadsheet software to estimate taxes. When an old tax return was run through the spreadsheet model, the total was $5,000 off the correct manual calculations. The error was traced to an incorrect formula for assessing salvage value in the model (*Business Week,* 1985).

As these cases demonstrate, end-user computing, like any other large-scale organizational activity needs to be controlled and managed. Unfortunately, although the need for control of EUC activities is well recognized (Alavi and Weiss, 1985-86; Benson, 1983; Davis and Olson, 1985; Henderson and Treacy, 1986; Rockart and Flannery, 1983), strategies for EUC control are neither well-developed nor have they been empirically tested. The focus of this paper is, therefore, on potential control strategies for EUC activities and their impact on end users.

CONTROL STRATEGIES

A basic principle of effective management is the need to exert and maintain appropriate control over organizational members' work-related activities. Generally, control is defined as any activity that has been designed to assure that actual operations conform to planned operations. Thus, the effective implementation of control requires a set of standards against which employees can be compared, information about any discrepancy between the employee and the standard, and actions that can correct any deviations (Donnelly, Gibson and Ivancevich, 1984).

According to Tannenbaum (1986), creating such a control system involves three relatively distinct phases. These include the legislative phase in which policies are determined, the administrative phase in which the policies are implemented, and the sanctions phase when employees are either rewarded or punished for their efforts. This final phase depends heavily on the existence of an appraisal process in order to determine who should receive rewards and/or punishments. Thus, control systems are directly tied to other organizational policies, including the measurement and evaluation of employee performance.

An integrated view of control strategies, therefore, requires an explicit consideration of how the strategy fits with these other organizational policies. Eisenhardt (1985), in fact, argues that most views of organizational control distinguish two basic forms of control -- behavior-based versus outcome-based -- that are characterized by differences in performance evaluation strategies. For this reason, we focused on these two particular forms of organizational control as possible mechanisms for use in an EUC environment.

Behavior Versus Outcome Based Control of EUC

As previously noted, organizations must actively control employee's work related activities. Control has, however, been a perplexing problem for researchers and practitioners since there is little agreement on the optimal distribution of control in organizations. For example, classical organizational theory (Blau, 1984; Fayol, 1949) and scientific management (Taylor, 1911) argue that control can be achieved most effectively through highly bureaucratic structures including close supervision, formal policies, detailed documentation, and specialized tasks. In relatively sharp contrast, the human relations movement (Likert, 1967; McGregor, 1966) and current models of job enrichment (Hackman and Oldham, 1976) suggest that increased autonomy, enlarged tasks, and greater decision-making authority might actually be more appropriate methods for inducing employees to produce desired outcomes.

Clearly, these perspectives differ in numerous ways, but one of the more salient ways concerns the degree of control afforded the employee over his/her own activities. Although not synonymous, classical organizational perspectives implicitly argue for greater use of strict behavioral

based control while enrichment perspectives suggest that outcome-based control may be more appropriate. That is, behavior-based control is characterized by the measurement and evaluation of the specific behavioral activities of employees. Thus close supervision of activities with substantial documentation are frequently encountered. Outcome-based control, on the other hand, relies primarily on the measurement and evaluation of outcomes (i.e., products) with less explicit control over the specific activities that produced those outcomes, thereby affording employees far greater personal control. Rewards, in turn, are then administered in a manner consistent with the focus of the appraisal, namely either behavior or outcomes.

From the organization's perspective, the choice between these two strategies should be governed primarily by task programmability, the sophistication and capacity of information systems in place, and the uncertainty associated with outcomes (Eisenhardt, 1985). According to Eisenhardt, behavior-based control is more appropriate when tasks are highly programmed, and the information system available is capable of measuring those behaviors necessary for completion of the tasks. Thus, this system requires considerable capacity since the amount of information to be collected can be extensive. In contrast, outcome-based control will generally be more suited to jobs that are more complex, but which have observable outcomes. This latter system clearly requires less information processing, but it forces employees to accept greater risk associated with responsibility and accountability for the outcomes produced.

Although both strategies are feasible for the control of EUC from the organization's standpoint, the ultimate success of any control system also depends, at least in part, on organizational members' perceptions of and reactions to the system. It is well documented in the organizational behavior literature that a sense of self-determination or personal control over one's outcomes is an essential ingredient of motivation and satisfaction (Deci, 1975; Fisher, 1978; Rosenfield, Folger and Adelman, 1980). A loss of self- determination is also a major contributing factor to work-related stress (Schuler, 1980). Moreover, stress and job dissatisfaction have been consistently related to each other (Sales and House, 1971). Any of these conditions can easily have long term detrimental implications for a control system such as resentment, withdrawal, or poor performance. Thus, the needs and desires of end users must be weighed into any decision about whether to employ behavior-based or outcome-based control strategies to manage EUC activities.

THE EXPERIMENT

The present research was designed to examine this latter issue. We wanted to assess whether end users would respond differently to behavior-based and outcome-based control strategies. It involved a comparison of these two control strategies in a laboratory setting for the purpose of obtaining data on end user's affective reactions to the control process and their task satisfaction under the different strategies.

Based upon organizational behavior research, we believed that behavior-based control of EUC would have detrimental effects for several reasons. First, research on job enrichment (Hackman and Oldham, 1976) indicates that perceived autonomy is significantly related to satisfaction. Second, as previously noted, a sense of self-determination is essential to the maintenance of motivation and satisfaction. Requiring end users to follow detailed procedures and documentation could easily lead to a perceived loss of self-determination.

We, therefore, hypothesized that subjects under behavior-based control would report lower levels of self-determination, greater levels of stress, and lower levels of task and process satisfaction than subjects under an outcome-based control strategy.

The Subjects

The subjects (36 males, 23 females) for the experiment were evening graduate students in two MIS classes from an urban university in the Southwest. The average age of the subjects participating in the experiment was 29 years, and 89% had full or part-time professional employment with various organizations in the area. A post experimental analysis indicated that there were no significant differences in the background of the subjects in these two classes in terms of their MIS experience or prior familiarity with the software tools employed in the experiment.

Experimental Task

The experimental task was a case analysis that involved developing an information system (using LOTUS 1 2 3 software) for analysis of a joint venture decision between a bank, a large retail chain, and a newly formed company in the video and telemarketing industry (Ten Dyke, Bodily and Long, 1982). The case description contained detailed background and data on the telemarketing industry and equipment, the production process and cost, and financial and market structure and projections. In summary, a wide array of potentially relevant data was made available in the case.

Each subject was required to assume the role of a staff analyst and make a recommendation on a go/no go decision for the joint venture. Each subject also developed an information system to support his/her analysis and recommendations. The analysis involved development of a workable price structure and financial arrangements as well as investigating the project's financial prospect, risk, and sensitivity to major assumptions. This project constituted 35% of each student's overall course grade.

Experimental Manipulations

The research design involved the manipulation of the strategy used to control end-user computing. Subjects in the *outcome-based control strategy* (n = 33) were provided with the case description and a brief project write-up explaining their task. They were given the deadline for turning in the completed project and were told that their project grade (reward) would be based on the completed project (the outcome). They were free to choose the approach used in developing their information system and could set their own work pace during the ten weeks allowed for project completion.

In order to simulate the typical characteristics of behavior-based control (observation and documentation of behavior; evaluation of behavior), subjects in the *behavior-based control strategy* (n = 26) were given specific instructions on the process (the activities and their sequence) that they were to follow in the design and implementation of the information system required in the task. They were required to closely follow the systems development life cycle (SDLC) process, which was reviewed in detail in class. At the outset of each phase of the SDLC, specially developed documentation forms corresponding to the phase were distributed to subjects. The subjects were instructed to follow, perform, and document the steps outlined in the form. For each phase of the SDLC, the subjects turned in the completed forms and a report at a preestablished deadline. The instructor then reviewed the forms and reports. Upon the satisfactory completion of a phase, the subjects were provided with new forms for the following phase of the SDLC. All phases of the SDLC were completed in this fashion. This behavior-based control strategy is depicted in Figure 1. Upon the satisfactory completion of each phase, the student was also give the score he/she earned for that phase.

Procedure

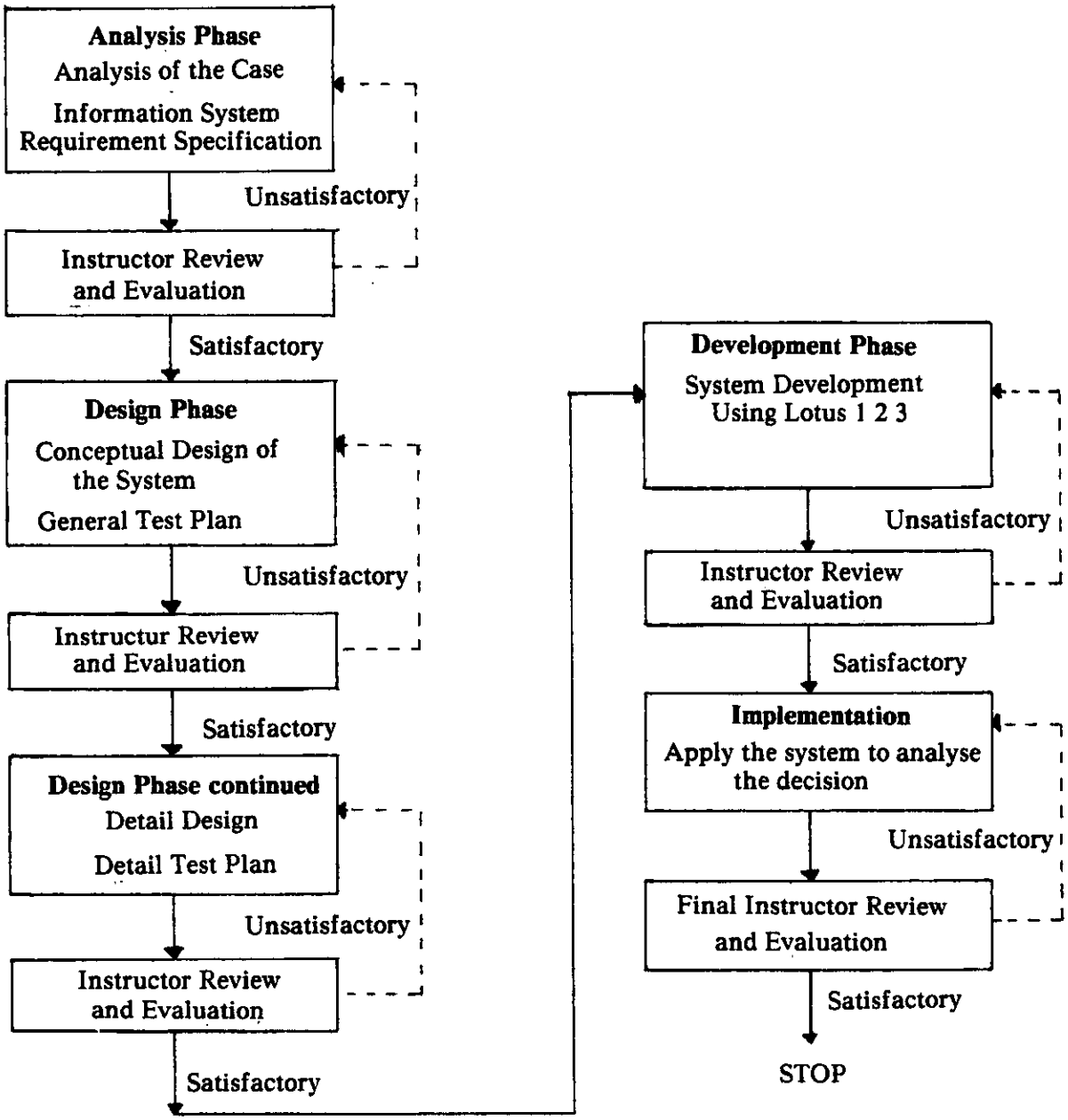
Before engaging in the task, subjects completed a brief questionnaire to collect background and demographic data. Next, students were instructed in the use of LOTUS 1 2 3. Through specific examples and tutorials, students used LOTUS 1 2 3 in a "hands on" mode. Homework assignments and exam questions assured that the students in both conditions had a good working knowledge and understanding of LOTUS 1 2 3 capabilities. This phase of the project took four weeks. The two classes were then randomly assigned to experimental conditions.

The experimental manipulation was completed over a ten week period. At the end of the exercise, subjects completed a questionnaire measuring general satisfaction with their task, process satisfaction, self-determination, and stress. The questionnaire also asked them to estimate the total amount of time spent developing their system, and to predict their project grades. Subjects were then debriefed and allowed to discuss the case in detail.

Dependent Variables

Task satisfaction was measured with five items adapted from Freedman and Phillips (1985). Subjects were asked to agree or disagree on 5-point Likert format scales with statements such as "Overall, I was satisfied with the project as a

Figure 1. Behavior-Based Control Strategy



class exercise." High scores on this scale indicated high levels of task satisfaction.

A measure of **process satisfaction**, included four 5-point Likert scale items, was developed to tap subjects' satisfaction with the process used by the instructor during the experiment. High scores on this scale, which included items such as "Overall, I was satisfied with the way the instructor conducted the project for students," indicated high levels of process satisfaction.

Self-determination was measured with a three item scale adapted from Freedman and Phillips (1985). The self-determination scale included items such as "I wish I had been given more freedom while working on the project." This scale was coded so that high scores represented high levels of self-determination.

Table 1. Descriptive Statistics for Dependent Variables by Control Strategy

Variable	Control Strategy: Behavior-Based	Control Strategy: Outcome-Based
Process Satisfaction		
Mean	2.34	2.77
Standard deviation	.78	.66
Task Satisfaction		
Mean	3.42	3.33
Standard deviation	.73	.77
Self-determination		
Mean	2.42	2.62
Standard deviation	.78	.66
Stress		
Mean	4.29	3.70
Standard deviation	.74	.74

Note. $\underline{n}=26$ for the behavior based control group; $\underline{n}=33$ for the outcome-based control group.

Finally, **stress** was measured with a five item scale adapted from Keller (1984). High scores on the stress scale which included items such as "At times, I experienced tension about the project" indicating high levels of stress.

STATISTICAL ANALYSES AND FINDINGS

Before examining the effects of the control manipulation on participants, product-moment correlations were calculated among the dependent variable to investigate the nature of any linear relationships that may have existed among these measures. Descriptive statistics for the dependent variables are presented in Table 1, and the correlations among these measures as well as coefficient alpha reliability estimates have been shown in Table 2. As can be seen, the correlations were generally consistent with our expectations. That is, high levels of stress were associated with lower process satisfaction; likewise, people who reported a lack of self-determination were less satisfied than people reporting more self-determination. Quite unexpectedly, however, stress and self-determination were essentially uncorrelated. Thus, a lack of self-determination may not have been the major source of stress among the overall sample.

Table 2. Correlations Among Dependent Variables

		(1)	(2)	(3)	(4)
Process Satisfaction	(1)	(.71)			
Task Satisfaction	(2)	.37**	(.65)		
Self-Determination	(3)	.30*	.32*	(.73)	
Stress	(4)	-.48**	-.14	-.14	(.87)

Note. Values in parentheses are coefficient alpha estimates of scale reliabilities.
$\underline{N}=59$
*$\underline{p} < .05$, two-tailed test
**$\underline{p} < .01$, two-tailed test

Turning now to the effects of the process control manipulation, a one way multivariate analysis of variance was computed using participants' reports of self-determination, stress, task satisfaction, and process satisfaction as the dependent variable set. This analysis (shown in Table 3) yielded a significant multivariate effect for the control manipulation, $F(4,54) = 3.28$, $p > .05$.[1]

To identify more specifically the nature of the difference between the groups, univariate analyses of variance were computed for each of the four dependent variables in the multivariate set. The results of these analyses also appear in Table 3. They clearly demonstrated that the significant multivariate effect was due to differences between the groups on stress, self-determination, and process satisfaction. For each of these measures, the results were consistent with our expectations. Subjects in the behavior-based control group reported greater levels of stress, less self-determination, and less process satisfaction than the outcome-based control group. Estimates of the proportion of variance in each measure attributable to the control strategy manipulation e^2 further indicated that this manipulation explained nearly twice as much variance in subjects' self-reports of stress (14%) than in either their process satisfaction (8%) or their feelings of self-determination (7%). Interestingly, this additional stress and dissatisfaction with the process did not translate into lower levels of overall task satisfaction.

To be certain that the effects of the control manipulation were not attributable to the differences in anticipated grades between the groups rather than actual process differences, the multivariate analysis of variance was recomputed. This time, however, participants' self-reports of anticipated project grades were used as a covariate. Controlling for this "nuisance variable" had no appreciable effect on the results. That is, the multivariate effect of the control strategy continued to be highly significant, $F(4,53) = 4.09$, $p > .01$. Thus, the difference between the groups was not merely an artifactual effect associated with different performance expectations.

[1]The F value represents an approximate F derived from the Wilks lambda multivariate criterion of significance.

Table 3: Multivariate and univariate analyses of variance of the effects of control strategies

	Univariate Tests			Multivariate Test	
Dependent Variable	SS	F[a]	ETA^2	Wilks Lambda	F[a]
Self Determination	2.13	4.19*	.07	.799	4.12**
Task Satisfaction	.10	.17	.00		
Process Satisfaction	2.64	5.19*	.08		
Stress	5.05	9.17**	.14		

[a]Degrees of freedom for the multivariate test were 4,54 and for the univariate tests the degrees of freedom were 1,57.

*$p < .05$

**$p < .01$

Finally, recall that our *a priori* expectations were that the behavior-based control strategy would be perceived to be stressful because of a loss of self-determination. Logically, this stress should, in turn, have led to lower levels of task and process satisfaction. As previously noted, the first stage of the model was not testable in the present sample since stress and self-determination were uncorrelated. However, in an exploratory test of the intervening effects of stress on the control process-satisfaction relationship, hierarchical regression analysis was used. Process satisfaction was first regressed onto participants' reports of stress. Then, the process control manipulation was entered into the prediction equation. If stress was, in fact, an important mediating variable, then once its effects were statistically controled, the control manipulation should have been associated with little, if any, explained variance in the measure of process satisfaction.

The results of the regression analysis provided support for this proposition. Alone, the control manipulation accounted for a statistically significant 8% of the variance in the measure of process satisfaction (see Table 3). When the effects of stress were controlled, the incremental variance in process satisfaction that was attributable to the control manipulation was a nonsignificant 1.5%, $F(1,56) = 1.05$, $p > .10$. Thus, virtually all of the effect of the control manipulation on process satisfaction could be attributed to its intervening effect on stress.

SUMMARY AND IMPLICATION

The results of the present study indicated that end users responded differently to behavior-based and outcome-based control strategies. Relative to outcome-based control, the behavior-based control resulted in lower levels of self-determination and process satisfaction, as well as greater levels of stress for participants in the study. Together, these results were generally consistent with predictions that had been derived from previous organizational behavior research on the determinants of intrinsic motivation. Specifically, a sense of self- determination (autonomy) has frequently been associated with positive affective task reactions (Deci, 1975; Hackman and Oldham, 1976; Phillips and Lord, 1980).

The results of an exploratory hierarchical regression analysis further suggested that the detrimental effect of behavior-based control on process satisfaction could be statistically explained through the mediating effect of stress. The data were consistent with our belief that behavior-based control imposed undue stress on participants which, in turn, resulted in lower levels of process satisfaction than outcome-based control.

The strength of the effect of our control strategy manipulation on stress, as well as its central role in explaining other effects, suggest that this may be the most noteworthy finding in the present study. Today, there is overwhelming evidence that high levels of organizationally induced stress have a variety of serious long term consequences for employees (House, 1974; Schuler, 1980). As a result, organizations are actively seeking ways to reduce the number of stressors in the work environment. Our results suggest that stringent behavior-based control may unnecessarily stress end users, with a subsequent effect on their satisfaction. Although there was no effect in the present study on overall task satisfaction, this lack of effect may have been due to the relatively limited duration of subjects' "jobs." Over longer periods of time it may be that this form of EUC control would lead to problems similar to those noted in other literature, including overall job dissatisfaction, resentment, withdrawal, and poor performance (House, 1974; Sales, 1970; Sales and House, 1971; Schuler, 1980).

Outcome-based control, however, may not always be a superior strategy to behavior-based methods for controlling EUC. Research has shown that too little stress (i.e., task underload) can lead to the same negative consequences as too much stress (Sales, 1970). Thus, the goal of any EUC control strategy should be to optimize, rather than minimize or eliminate stress. This is an especially important fact to note since we employed very stringent behavior-based control methods. Subjects were closely monitored, were required to adhere to a specific model of system development, and were required to carefully document their activities, all within a rigid time frame. Despite the strength of this manipulation, stress and self-determination were not significantly correlated. This at least suggests that many aspects of behavior-based control were not perceived negatively by the participants. Some aspects may, in fact, have been viewed positively. For example, it may be that behavior-

based control strategies provide more immediate feedback to participants on their progress. Moreover, it might "force" them not to procrastinate. Thus, what we are suggesting is that organizations may want to capitalize on the strengths of both behavior and outcome-based control for managing end-user computing activities. To this end, future research on EUC should continue to examine the *specific* causes of stress and dissatisfaction associated with these different forms of control.

It should also be noted once again that there was no significant difference between the behavior-based and outcome-based control groups on participants' overall task satisfaction. Moreover, self-reported estimates of time spent developing the system, as well as expected project grades, were unaffected by the manipulation. Thus, the two control strategies had similar effects on participants' overall project behavior. They differed primarily on their feelings toward the *process* in which they engaged to produce these outcomes. This means that future research should carefully evaluate process sources of stress and self-determination in an EUC environment before the"ideal" control strategy can be developed. We can, however, offer several general suggestions about the nature of this control system as a result of our research.

First, EUC is generally viewed as a creative activity. Care should, therefore, be taken not to constrain employees so much that they lose interest in their end-user computing activities. Situationally constraining otherwise interesting jobs frequently leads to such undesirable consequences (Freedman and Phillips, 1985).

Second, as illustrated by the vignettes at the beginning of this paper, there exists a genuine need to monitor EUC activities. Our results suggest, however, that monitoring should not take the form of stringent behavior-based control. An alternative would be to implement regular reporting and review activities, but without overburdening the end users with detailed and extensive procedures and documentation. More important, since self- determination was affected by our manipulation and it does play an important role in maintaining intrinsic motivation (Deci, 1975), these monitoring procedures should continue to allow for substantial flexibility and autonomy in the end-user computing activities.

In sum, EUC needs to be controlled just as any other work-related activity. This control necessarily involves the establishment of EUC policies, the development of standards for defining acceptable end-user behaviors, and finally, the administration of appropriate rewards and punishments. Our results suggest that the mechanisms for monitoring EUC activities should not rest solely with the stringent behavior-based strategies. Clearly, however, the present study primarily addressed one facet of the relatively complex system we have just outlined. Future research should examine the effects of control strategies not only over time, but also within this broader organizational contact.

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