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UNDERSTANDING REACTIONS TO JOB REDESIGN: A QUASI-EXPERIMENTAL INVESTIGATION OF THE MODERATING EFFECTS OF ORGANIZATIONAL CONTEXT ON PERCEPTIONS OF PERFORMANCE BEHAVIOR

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Redesigning jobs from a traditional workgroup structure to a semi-autonomous team structure has become increasingly popular, but the impact of such redesigns on employee effectiveness criteria has been mixed. The present longitudinal quasi-experimental study showed that although such a redesign had positive effects on 3 performance behaviors (effort, skill usage, and problem solving), its effectiveness also depended on aspects of the organizational context. In conditions where the organizational reward and feedback and information systems were effective, redesigning work into a semi-autonomous team structure had no discernible effect on performance behaviors. In conditions where these systems were poor, however, such a redesign produced large positive benefits. This suggests that work redesigns that enhance worker autonomy are most effective in contexts where other supportive management systems are absent.

Team-based approaches to organizing work have become very popular in the last 2 decades in the United States (Ilgen, Hollenbeck, Johnson, & Jundt, 2005). In many instances, organizations have decided to redesign

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work (at considerable effort and expense) from individually oriented jobs in traditional workgroup structures to more autonomous team structures. In traditional workgroups, employees perform production activities but have no management responsibility or control over planning, organizing, directing, staffing, or monitoring, whereas in semi-autonomous teams, employees both manage and execute major production activities (Banker, Field, Schroeder, & Sinha, 1996). It is hoped that structuring work into semi-autonomous teams will enhance effort, cooperation, communication, skill utilization, learning, and problem solving when compared with more independent forms of work design (e.g., Gladstein, 1984; Hackman, 1987; Katzell & Guzzo, 1983).

If the voluminous popular business press is to be believed, the use of semi-autonomous teams is a sort of panacea for organizational ills and is generally preferred to traditional workgroups (Becker-Reems & Garrett, 1998; Cloke & Goldsmith, 2002; Fisher, 1999; Katzenbach & Smith, 1994; Wellins, Byham, & Wilson, 1993). Autonomous and semi-autonomous teams have been forwarded as a way of transforming "isolated, reluctant, cynical, immature, apathetic employees" into "connected, motivated, value-driven, responsible employee-owners" (Cloke & Goldsmith, 2002, p. 4). In addition, it has been suggested that "any team—if it focuses on performance regardless of where it is in the organization or what it does—will deliver results beyond what individuals acting alone in non-team working situations could achieve" (Katzenbach & Smith, 1994, p. 12). Such a belief in the transformative powers of teams has been termed the "romance of teams" by some (Allen & Hecht, 2004).

Such promotion of semi-autonomous teams, however, may simply reflect management fashion, or the "relatively transitory collective belief, disseminated by management fashion setters, that a management technique leads [sic] rational management progress" (Abrahamson, 1996, p. 257). According to Abrahamson (1991, 1996), management fashions present two dangers to organizations: (a) following the advice of management fashion setters (e.g., consulting firms, management gurus, and mass-media publications), organizations may adopt technically inefficient administrative technologies; or (b) organizations may reject technically efficient administrative technologies that are not currently fashionable.

If semi-autonomous teams are merely a management fashion, it is likely that many organizations have redesigned work into team-based structures when they were not really needed. Research that has investigated the effectiveness of team-based designs suggests that this might actually be occurring, in that some have found positive results (Banker et al., 1996; Campion, Medsker, & Higgs, 1993; Campion, Papper, & Medsker, 1996), whereas others have shown mixed (Cordery, Mueller, & Smith, 1991; Staw & Epstein, 2000; Wall, Kemp, Jackson, & Clegg, 1986) or negative (Katz, Kochan, & Keefe, 1987) results. These varied results suggest that the effectiveness of transitioning to team-based designs depends on other factors, in which case organizations should consider these factors before deciding to redesign work into more semi-autonomous structures.

The danger, of course, lies in the costs and risks that organizations take when redesigning work. Increasing the autonomy of workers through the use of semi-autonomous teams means that organizations cede control to the workers, thus putting themselves at risk that the workers will make poor decisions, be negligent in their duties, or otherwise act in ways that are inconsistent with organizational interests (Eisenhardt, 1989). Moreover, although autonomy may be easily given, it is not easily taken back (Morgeson, Aiman-Smith, & Campion, 1997). Therefore, an organization that redesigns jobs into more semi-autonomous structures and finds that they did not work is likely to encounter great difficulty reverting to their former design. Finally, research has shown that process losses can occur in team-based structures (Steiner, 1972). Conformity pressures (Asch, 1955; Hackman, 1992), group polarization (Meyers & Lamm, 1976), social loafing (Latané, Williams, & Harkins, 1979), and free-riding (Albanese & Van Fleet, 1985) are well-known problems associated with team- or group-based work. As such, it is not clear that organizing work around teams is always better than organizing it around individuals.

Given these risks organizations incur in moving to semi-autonomous team designs, it is surprising that relatively little systematic empirical research has investigated work redesigns in which jobs that were performed in traditional workgroups are redesigned into more semi-autonomous teams and shown when it is most appropriate. We sought to address this gap in the literature by first showing whether the transition to a semi-autonomous team structure can benefit an organization and then identifying the contexts within which such a structure is most beneficial. Using a longitudinal quasi-experimental design in a field setting, we examined the role that organizational context can play in determining the extent to which a transition to a semi-autonomous team design will produce positive outcomes.

Why Semi-Autonomous Team Designs Enhance Performance Behavior

Many anecdotal accounts and descriptive case studies attest to the positive effects of team-based work design (as noted by Guzzo & Shea, 1992). The results of empirical research vary, however, depending on what outcome the team-based design was proposed to affect. The few studies that have been done have found positive effects on *attitudinal* variables like satisfaction (Cordery et al., 1991; Wall et al., 1986), organizational commitment (Cohen, Chang, & Ledford, 1997; Cordery et al., 1991), and quality of work life (Cohen & Ledford, 1994). The relationship of team-based designs with *performance* measures is decidedly more mixed, with positive findings on productivity and quality (Banker et al., 1996; Campion et al., 1993), and ratings of performance (Campion et al., 1993; Cohen & Ledford, 1994), whereas others have found no relationship[1] (Hollenbeck, Ilgen, Tuttle, & Sego, 1995; Wall et al., 1986) or even negative relationships with performance (Katz et al., 1987).

One way to reconcile these mixed results is to recognize that team-based designs generally affect more proximal outcome measures. Thus, affective outcomes and team member behaviors are more likely to improve following team redesign than more distal outcomes such as team performance. In developing their theory of performance, Campbell, McCloy, Oppler, and Sager (1993) have explicitly acknowledged such a phenomenon, distinguishing between performance as *behavior* and performance as *results*, noting that only performance behaviors are under the control of the individual job holder. This suggests that the effectiveness of team-based designs can perhaps best be determined by looking at the more proximal criteria of individual performance behaviors, rather than at distal performance results (Beal, Cohen, Burke, & McLendon, 2003). Interestingly, this distinction has been made in team effectiveness research as well, where performance behaviors have been referred to as "process criteria" (Hackman, 1987). In contrast to performance results, processes describe the behaviors of team members that are presumed to either promote or inhibit performance results.

In his highly influential (yet little studied; see Seers, 1996) model of team effectiveness, Hackman (1987) suggested that three distinct performance behaviors should be affected by team designs. First, team designs should influence the level of effort expended by team members. Effort levels reflect the degree to which team members are committed to and feel accountable for the team and its work. Second, team designs should influence the degree to which team members apply their unique knowledge and skills to the team's task. Skill usage levels reflect the extent to which teams distribute their tasks so that member skills are utilized efficiently. Third, the extent to which teams have defined performance strategies will result in better developed problem-solving capabilities. Hackman's conceptualization of this third performance behavior involved the notion of strategy slippage: the degree to which team plans need to be changed due to obstacles. Thus, the degree to which teams are able to solve problems

[1] Wall et al. (1986) found no performance effect but did find a productivity effect because of a reduction in indirect labor costs.

effectively allows them to reduce slippage because they can anticipate problems and modify plans accordingly.

Despite the fact that team-based designs have been put forward as a way to affect these performance behaviors, no study has actually examined the effects of implementing team-based designs on individual performance behaviors. Consequently, not only is the extent to which team designs affect performance behaviors unclear, the causal mechanism(s) by which team designs affect these behaviors is not well understood. Previous research in the work design literature suggests that perhaps the key causal mechanism is group autonomy.

A key difference between traditional workgroups and semi-autonomous teams is the level of autonomy experienced by team members (Banker et al., 1996; Langfred, 2000). Research has shown that increased autonomy has at least three benefits (Cummings, 1978; Trist & Bamforth, 1951). First, the motivational benefits of increased autonomy have been well documented in the work design and sociotechnical system theory literatures (Morgeson & Campion, 2003). Increased autonomy is motivating, resulting in greater effort on the part of team members. Second, increased autonomy allows team members to self-manage. In cross-sectional research, Campion and colleagues (Campion et al., 1993, 1996) found that team self-management was positively related to such performance behaviors as effort, intragroup cooperation, communication, and peer helping behaviors. In addition, Parker (2003) found that when autonomy was reduced through lean production practices, employee-reported skill utilization also declined. This suggests that increased autonomy should lead to increased utilization of employee skills. Third, increases in autonomy allow an organization to tap into the existing knowledge of the workforce as well as fostering further learning (Parker, Wall, & Jackson, 1997; Wall & Jackson, 1995). If employees learn more about an organizational system, they are better able to anticipate and avoid problems (Wall, Jackson, & Davids, 1992). Thus, job incumbents are better able to leverage their existing knowledge (and develop new knowledge), enhancing problem-solving behaviors.

> *Hypotheses 1–3*: Individuals whose jobs have been redesigned into a semi-autonomous team structure will show greater improvement on (1) effort expended, (2) skill usage, and (3) problem solving than those who remain in traditional workgroups.

The Moderating Effects of Organizational Context

The preceding hypotheses suggest that there are at least three reasons why a redesign into a semi-autonomous team structure will yield improvements in performance behaviors. Yet, these arguments do not take

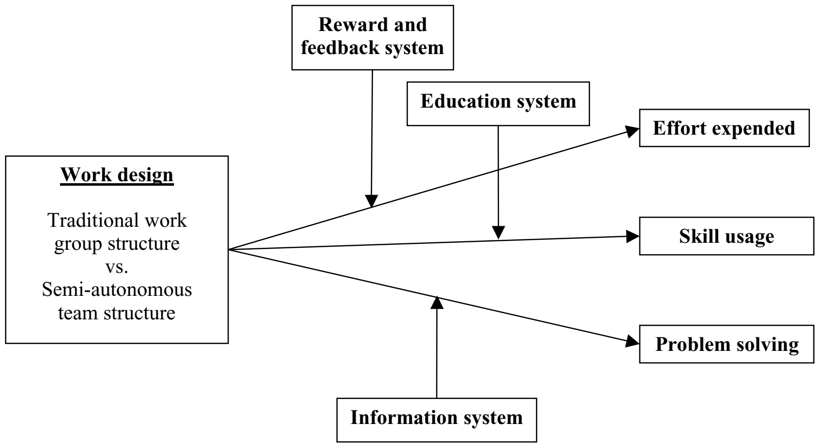


Figure 1: **Model of the Moderating Effects of Organizational Systems on Work Design.**

into account the possibility that aspects of the organizational context can serve to substitute for the motivational, self-management, and knowledge-enhancement benefits that often attend the use of semi-autonomous team structures. In other words, the nature of the context might make a redesign to a semi-autonomous team structure more or less appropriate.

Although context has generally been neglected in organizational research (Cappelli & Sherer, 1991), Hackman (1987) developed a normative model of group effectiveness that explicitly identifies three important aspects of the organizational context. He suggested that reward and feedback systems, education systems, and information systems can influence functioning in team structures (Figure 1). Because this normative model is "essentially a theoretical statement in which existing knowledge is reconfigured" (Hackman, 1987, p. 316) and has not been empirically tested (Seers, 1996), we develop hypotheses to explicitly test the components of Hackman's (1987) normative model.

Reward and Feedback Systems

An organization's *reward and feedback system* can either reinforce or undermine the motivational benefits of work tasks. Reward and feedback systems consist of both formal and informal elements. Formally, effective reward and feedback systems provide positive consequences for excellent performance, where good performance is recognized and rewards are at least partially contingent upon performance. Informally, the feedback one gets from one's supervisor, coworker, or even the task itself is rewarding if one is performing well. In Hackman's (1987) model, the reward and feedback system is proposed to affect the first of the performance behaviors: the amount of effort expended by members to the group task.

One of the challenges associated with environments where work is performed by groups is the potential motivational losses that may occur (Shepperd, 1993). Social loafing occurs when there is “a decrease in individual effort due to the social presence of other persons” (Latané et al., 1979, p. 823). Free-rider effects refer to the tendency of individuals to withhold effort if they feel they can receive sufficient outcomes by letting others do the work (Albanese & Van Fleet, 1985). Kidwell and Bennett (1993) suggested that both of these concepts reflect a general propensity to withhold effort, which is moderated by contextual factors. One key contextual factor identified is the reward and feedback system within which groups operate. In essence, individuals may expend less effort because they are neither rewarded nor punished (Jones, 1984).

A great deal of research has supported the link between formal and informal rewards and effort. In terms of formal rewards, in their meta-analytic investigation, Guzzo, Jette, and Katzell (1985) found that monetary incentives had the greatest effect (beyond work redesign and other policy changes) on productivity, withdrawal, and disruption. In terms of informal rewards, feedback has been shown to have a strong influence on productivity, persistence, and performance (Barr & Conlon, 1994; Guzzo et al., 1985; Pritchard, Jones, Roth, Stuebing, & Ekeberg, 1988). Thus, team members would be expected to engage in less social loafing and feel more committed to their workgroup’s task under effective reward and feedback systems.

Although this research (and Hackman, 1987) suggests that effective reward and feedback systems improve team member effort, we suggest that effective reward and feedback systems will in fact attenuate the positive effect of redesigning work into semi-autonomous teams. In situations where the reward and feedback system is effective, moving to a semi-autonomous team-based design will have negligible effects on the amount of effort employees expend. In situations where the reward and feedback system is poor, however, moving to a semi-autonomous team-based design will have large positive effects on employee effort. In essence, rewards and team structures can be seen as alternative methods for motivating effort. If the organization has an effective reward and feedback system, employees are already motivated and will exert high levels of effort. If the organization has a poor reward and feedback system, however, redesigning work into teams creates positive motivational conditions, in part because of the motivational benefits of group autonomy, as noted above. Thus, we would expect that the positive motivational effects of team-based designs will be largely redundant in situations where the reward and feedback system is effective.

> *Hypothesis 4*: The relationship between the redesign into semi-autonomous team structures and the amount of effort expended will be moderated by the reward and feedback system, such that the use of semi-autonomous team structures will result in increased effort expended when there are poor existing reward and feedback systems.

Education Systems

The second contextual factor expected to impact performance behaviors is an organization's *education system*. It determines the extent to which groups have the knowledge and skills necessary to carry out their tasks (Hackman, 1987). In an organizational context, this is reflected in the availability of training resources and the effectiveness in delivering these resources to employees. Such training would include a focus on the specific tasks performed in different jobs, as well as the knowledge and skills needed to work effectively with others (i.e., interpersonal and self-management aspects; see Stevens & Campion, 1994). When the education system is effective, employees can apply new knowledge and skills to their tasks and can learn collectively. Recent meta-analytic research suggests that training programs have a moderate to large effect on a variety of different criteria (Arthur, Bennett, Edens, & Bell, 2003).

The empirical literature on team-based design implementation, however, appears to have confounded the implementation of teams with training provided to the employees. For example, the team-based design interventions in both Wall et al. (1986) and Cordery et al. (1991) included new training provided to the employees whose work was redesigned into teams. Thus, it is unclear whether the improvements in performance and attitudinal outcomes were due to the work redesign or to the education system under which the teams worked. We separated training from the work redesign, and thus, the effects of the redesign can be examined independently.

Hackman (1987) suggested that good educational systems should enhance the application of team member skills to the team's task. Similar to the moderating effects of an organization's reward and feedback system, however, we expect that in situations where the education system is effective, implementing a team-based design will not significantly impact the application of knowledge and skill. Conversely, in situations where the education system is poor, implementing a team-based design will have large positive effects. In essence, training and team-based designs can be seen as alternative methods for imputing KSAs to employees. If the organization has an effective education system, employees are receiving the appropriate KSAs that they can apply to their tasks. If the organization has a poor education system, however, introducing a team structure creates conditions where employees are likely to transfer knowledge and skills to each other via more informal means. The interdependence that is inherent in team-based designs means that team members can learn from their own experiences, as well as the experiences of other team members (Ellis, Hollenbeck, Ilgen, Porter, West, & Moon, 2003).

> *Hypothesis 5*: The relationship between the redesign into semi-autonomous team structures and skill usage will be moderated by the education system, such that the use of semi-autonomous team structures will result in increased skill usage when there are poor education systems.

Information Systems

The third contextual factor is an organization's *information system*. When team members have information about other areas of the organization, they are able to solve problems more effectively (Hackman, 1987). This is because problem solving is a fundamentally information-driven process: The greater the available information, the more likely team members will be able to solve a given problem facing the team. This is consistent with research that shows that increasing independent sources of information allows individuals to make more accurate decisions (Stevenson, Busemeyer, & Naylor, 1990), and much of the work in knowledge management is predicated on this premise (Alavi, 2000).

Again, we suggest that rather than simply improving the problem solving of teams in general, an organization's information system will serve to moderate the effects of redesigning work into semi-autonomous team structures. In contexts where information is readily available, implementing semi-autonomous teams will not produce significant improvements in problem solving, but in situations where information is not readily available, such a redesign will have large benefits. This is due to the fact that organizationally based information systems and semi-autonomous team structures can be viewed as alternative methods for disseminating information to employees. In traditional workgroups, employees often rely on relatively few formal channels of communication to obtain information about other areas of the organization. When these channels are effective, employees have access to a wealth of information that should enhance their individual abilities to solve problems.

When employees work in semi-autonomous team structures, however, they have horizontal access to information held by their teammates, in addition to the hierarchical channels. This means that the team is likely able to access multiple independent sources of information relevant to the problems they face and, thus, are likely to come up with more effective solutions. Indeed, research has shown that groups by and large solve problems more effectively than individuals (Culvenor, 2003; Laughlin, Bonner,

& Miner, 2002).[2] This notion is supported by organizational research on transactive memory; when work team members are aware of "who knows what," they tend to have higher performance (Austin, 2003). These benefits are likely to be greatest when the formal information system is poor. In essence, then, the transactive memory system can substitute for poor information systems. When information systems are effective, individuals in semi-autonomous team structures will not have access to better sources of information than traditional workgroups and, thus, should not solve problems more effectively.

> *Hypothesis 6*: The relationship between the redesign into semi-autonomous team structures and problem solving will be moderated by the information system, such that the use of semi-autonomous team structures will result in increased problem solving when there are poor information systems.

Method

Work Redesign Intervention

This quasi-experimental study was conducted in a large midwestern U.S. printing company. At the start of the study, work was organized around traditional workgroups. The work performed by the production workers encompassed all the jobs required to design, print, and ship printed material. This included craft jobs (e.g., pressman, assistant pressman, roll tender, binder operator, assistant binder operator, machinist, boiler operator, preliminary technician, layout), what were called operative jobs (e.g., hoist operator, tab checker, bundler, baler operator, press technician, bindery technician, material expediter, production clerk, shipping/receiving clerk), and support crew jobs (e.g., material handler, trucker, jogger, mail clerk). In addition, a small number of administrative jobs (e.g., engineer, HR representative) were included in the sample. Workers were responsible for their own jobs, and work was formally directed and coordinated by a single supervisor (such as a lead press operator).

The decision on the part of the company to redesign work into semi-autonomous teams stemmed from a decision to invest in new technology. The investment decision was used as a springboard to implement improvements in management practices. Based partly on the technical

[2]It should be noted, however, that there are situations where individuals working alone will solve problems more efficiently than interacting teams. For example, teams often do not perform as well as individuals because they exert less effort than they would individually (i.e., social loafing) and because they have to devote time and effort to coordinating their actions with each other (i.e., coordination losses).

changes and partly on the judgment of organizational development experts within the company, a sociotechnical systems approach guided the intervention (see Pasmore, 1988, for an illustration of these approaches). Our role was to provide an independent evaluation of the effectiveness of the work design changes. External consultants designed and implemented the intervention.

Two plants in the same location were involved in the intervention. Three shifts across 12 production departments operated 7 days a week, 24 hours a day. Each department performed similar work but made different products. For example, some departments produced newspaper inserts, others produced small magazines, and a few produced large magazines and catalogs. As part of the intervention, the plants were scrutinized from a sociotechnical systems perspective. The environmental requirements (i.e., suppliers and internal and external customers), technical process flows and variances, and social processes and structures were all examined. The objective was to determine what new organizational design would optimize the performance of both technical and social systems and create a high performing team-based organization.

The change process used to implement the sociotechnical approach involved conferences conducted by consultants and attended by employees. This approach (Axelrod, 1992) began with a sociotechnical systems analysis used to create specific proposals for the new organizational design. It involved significant employee participation to enhance understanding and commitment and reduce the time required to implement redesign changes.

The ultimate decision to implement teams was left up to departmental managers. Because each of the managers was interested in experimenting with teams, the respondents were almost evenly split into traditional workgroups and semi-autonomous teams across departments. After the redesign, some of the work was organized into semi-autonomous teams. Compared to traditional workgroups, semi-autonomous teams had enhanced responsibility and participation in decision making in the areas of order setup, coordinating their work with others in the team (e.g., coordinating the interdependent work of the pressman, binder operator, and plater), the ordering of print jobs to perform most efficiently, checking and ensuring the quality of printed output, conducting routine maintenance, and the assignment of team members to tasks. For example, in traditional workgroups, the formally designated leader would make the decision about the order in which the different print jobs should be completed. In semi-autonomous teams, however, these kinds of work scheduling decisions were made by the entire team in a participatory manner. The data were collected 1 year apart, with the intervention occurring in between, thus providing both pre- and posttest assessments of all variables in the framework.

Sample and Procedure

There were 914 employees in the total pretest sample and 1,030 employees in the total posttest sample (staffing levels increased during the intervening time period) across two locations, representing a response rate of over 90% at each time period. In the pretest sample, 71% were males, and respondents had an average of 17 years with the organization ($SD = 9.93$). In the posttest sample, 56% had been restructured into teams, 66% were males, and respondents had an average of 14 years with the organization ($SD = 11.1$).

Because anonymity was a major organizational concern, we asked respondents to record a personal identification number, chosen by and known only to them, on their questionnaire at the time of the pretest. They were asked to put this same number on the posttest questionnaire so data could be matched. They were not asked for any information that might link them to a specific workgroup. Successful matches of identification numbers could be made on 258 (27%) of the posttest respondents in 10 departments, with an average of 26 employees in each department ($SD = 23.5$).

At least four reasons prevented additional matches: (a) turnover: employees who worked for the organization at pretest no longer worked for the organization at posttest, or vice versa; (b) absence: employees were absent on either the day of the pretest or the posttest; (c) duplicate numbers: employees chose the same identification number (e.g., their birthdate, 999999, 123456); and (d) individuals did not keep a record of or intentionally omitted their number. Data from this sample, henceforth called the "matched sample," was used for all analyses. Of this matched sample, 52% were in semi-autonomous teams, 64% were males, and respondents had an average of 17.2 years with the organization ($SD = 10.2$). These percentages correspond closely to those of the total sample, as reported above.

Analyses were conducted to test whether results for the sample of individuals who had matching identification codes in the pre- and posttests would be similar to those for the unmatched sample. Regarding demographic and work-related characteristics, χ^2 and ANOVA analysis indicated that the matched sample did not differ significantly from the unmatched sample on gender ($\chi^2_1 = 0.41$, *ns*), the shift they worked ($\chi^2_4 = 8.40$, *ns*), or tenure with the organization ($F_{1,846} = 0.00$, *ns*). Consistent with the recommendations of Goodman and Blum (1996), we used multiple logistic regression to test whether individuals whose code could be matched were significantly different from those who could not be matched in terms of the pretest variables. Results indicated no statistically significant regression coefficients for any of the pretest variables, and the overall step was not significant ($\chi^2_9 = 9.54$, *ns*), indicating that the probability of being included in the matched sample was not dependent on any of the pretest variables. Thus, the matched and unmatched samples are the same on the key study variables, indicating no nonresponse bias.

Measures

A 5-point response scale ranging from 5=*strongly agree* to 1=*strongly disagree* was used for all measures. At the pretest, all employees were in traditional workgroups; at the posttest, approximately half of the employees were in semi-autonomous work teams. Thus, both pre- and posttest surveys referenced the employee's "workgroup," so the questions would apply to people in traditional workgroups, as well as people in semi-autonomous teams. This enabled the same items to be used on both pre- and posttest questionnaires and avoided potential instrumentation effects (Cook & Campbell, 1979). Employees completed the same survey at the pre- and posttest and indicated on the survey which department they worked in.

Department context. Education systems were measured using a three-item measure from Campion et al. (1993). The items were "The company provides adequate technical training for my work group," "The company provides adequate quality and customer awareness training for my work group," and "The company provides adequate team-related training for my work group (e.g., communication, problem solving, interpersonal, etc.)." Coefficient alpha in our sample was .79 at pretest, and .83 at posttest. *Reward* and *information systems* were measured using three-item scales adapted from Pasmore (1988). The reward and feedback system items were "Most people are rewarded based upon their performance," "Supervisors regularly let people know how well they are doing," and "Other members of your work group regularly let you know how well you are doing." This measure contains both formal (i.e., pay) and informal (i.e., feedback) reward elements. Because rewards are designed to motivate effort, it is important to assess the extent to which efforts are formally and informally rewarded. Coefficient alpha was .71 at pretest and .72 at posttest. The information system items were "My work group has adequate information about other departments," "My work group has adequate information about our customers and suppliers," and "My work group understands the needs and objectives of other groups with which we work." Coefficient alpha was .75 at pretest and .80 at posttest.

Performance behaviors. All of the performance behaviors were two-item scales adapted from Pasmore (1988). Effort was measured with these items: "People in my area work very hard" and "People in my area try very hard to perform at their highest level." Coefficient alpha was .85 at pretest and .88 at posttest. Skill usage was measured with these items: "Working here makes good use of people's capabilities" and "People in my work group are able to use a variety of knowledge and skills on their jobs." Coefficient alpha was .71 at pretest and .70 at posttest. Problem solving was measured with these items: "My work group is very good at solving technical problems" and "My work group is very good at solving interpersonal problems." These items reflect perceptions of the performance behaviors of other group members. Coefficient alpha was .65 at pretest and .74 at posttest.

Group autonomy. Because our arguments for the beneficial effects of semi-autonomous teams focused on increased autonomy as the key causal mechanism, we measured group autonomy as a manipulation check. This was measured using a five-item scale of self-management adapted from Campion et al. (1993). The items were: "My work group (rather than my supervisors) decide who does what tasks within the group," "Most work-related decisions are made by the members of my group rather than by my supervisors," "Supervisors explain what needs to be done and let group members figure out how to do it," "When problems arise, supervisors count on group members to solve it," and "Supervisors view their role as coaches; their job is to help the work group succeed, not to give orders." Coefficient alpha for this scale was .77 at pretest and .81 at posttest.

Control variables. To control for potential differences between men and women and longer-tenured employees, we included gender and organizational tenure as control variables in the analyses.[3] We included controls for gender and tenure because these demographic factors were related to some of the contextual and dependent variables included in the study. The control variables were measured with single self-report items, where employees indicated their gender and how many years they had been with the organization at pretest.

Analytic Strategy

Because of the multilevel nature of our hypotheses, we analyzed the data with hierarchical linear modeling (HLM) using HLM 6 (Raudenbush, Bryk, & Congdon, 2004). HLM allows one to estimate simultaneously the effects of variables across more than one level of analysis (Hofmann, 1997; Hofmann, Griffin, & Gavin, 2000). In our case, individual-level responses represented the Level 1 variables, and the aggregated department measures represented the Level 2 variables. In HLM, the intercepts and regression slopes representing the relationship between two Level 1 variables are estimated for each of the higher-level units. Thus, relationships between Level 1 variables take into account their nesting in higher-order units. Then both the intercepts and the slopes are regressed on the Level 2

[3]We also conducted the analyses without the control variables and found no differences in the results.

variables; significant differences between the intercepts (intercepts-as-outcomes) demonstrate that the means of the dependent variable vary across higher-level units, and significant differences between the slopes (slopes-as-outcomes) indicate interactions between the Level 1 and the Level 2 variables. In this study, the main effect hypotheses (1–3) would be supported if the relationship between work design and the performance behaviors was significant while controlling for the nesting of individuals within departments. The interaction hypotheses (4–6) would be supported if the slopes of the lines representing the relationship between work design and the performance behaviors varied significantly across departments.

Level of Analysis

In this study, the performance behaviors were measured at the individual level and the contextual variables were measured at the individual level and aggregated to the department level (not the group level). In addition, the items referenced groups and not individuals or departments. Clearly, it would have been ideal to have been able to link individual responses to their workgroups and then conduct HLM analyses using individual- and group-level variables. Unfortunately, we did not have access to group-level identifiers that would have enabled us to link individual responses to particular groups. As noted earlier, in this organization there were considerable concerns about respondent anonymity. This prevented the collection of the desired data. Nevertheless as described below, there are three conceptual reasons as to why the department level is an appropriate level of aggregation and analysis in this study. Moreover, we highlight other research to show that our method is not unusual and provide empirical data that support these conceptual reasons.

First, when developing multilevel models, others have suggested that it is important to clearly distinguish between the level of theory and the level of measurement (Klein, Dansereau, & Hall, 1994; Morgeson & Hofmann, 1999; Rousseau, 1985). The level of theory describes the target (e.g., individual, group, department) that the researcher is attempting to describe and explain. As such, it concerns the level at which constructs and theoretical relations are hypothesized to exist and the level to which inferences are to be drawn. Level of measurement, on the other hand, describes the actual source of data. This suggests it is possible for constructs and theoretical relationships to reside at one level (e.g., the department), although actual measurement occurs at another level (e.g., the individual). Our conceptual model explicitly suggests the important role the department context can have on performance behaviors.

Others have indicated that the department represents a legitimate level of theory in organizational research. For example, Litwak (1961) argued that intraorganizational variation in structure usually falls along departmental lines. Specifically, his model suggested that some departments typically engage in tasks that deal with predictable events and uniform tasks, whereas other departments engage in tasks that require social or creative skills. This approach was also adopted by Hall (1962) in his analysis of interdepartmental differences in 10 organizations. Similarly, Lawrence and Lorsch (1967) identified the department as the key level of differentiation within organizations, and Van de Ven and Delbecq (1974) explained intraorganizational variation by focusing on differences between departments. Perhaps most similar to our study, Ford (1981) used the department level to examine contextual effects on leader behaviors, finding that differences across departments in size, education level, task routineness, and environmental uncertainty predicted differences in consideration and initiating structure among leaders in each department.

Second, Rousseau (1985) and Chan (1998) have shown the importance of articulating a composition model to justify the level of measurement chosen. Typically, multilevel research uses either a referent shift model or an additive model when measuring a construct at a lower level than the level of theory. Because the intervention occurred at the group level, our interest involved how this change to the working structure affected the behaviors of the members of those groups. Given this, we chose to ask individuals about what happened in the group as a whole. This type of referent shift (Chan, 1998) is often recommended when dealing with a phenomena that exists at the collective level (Glick, 1985; Morgeson & Hofmann, 1999). To aggregate these measures to the department level, however, we used an additive model (specifically, a direct consensus compositional model). This is probably the most familiar and popular form of composition among multilevel researchers (Chan, 1998).

Third, the fact that the items referenced one particular level (the group) but were aggregated to a higher level (the department) is quite common in various research literatures. For example, studies that investigate team ability and personality commonly measure the constructs at the individual level (that explicitly reference the individual) yet justifiably aggregate them to the team level (e.g., Barrick, Stewart, Neubert, & Mount, 1998). Similarly, the justice literature has aggregated individual perceptions of justice to the team level (e.g., Colquitt, Noe, & Jackson, 2002; Liao & Rupp, 2005), as well as to the department and business-unit level (Simons & Roberson, 2003), despite the fact that the items explicitly reference how fairly the individual was treated. Thus, the aggregation of individual responses to higher levels is quite common.

Given this, the department appears to be the appropriate level conceptually and analytically. The question, then, becomes an empirical one: Do the department members show enough agreement to justify aggregating their perceptions to the department level? To create the contextual variables, we used the data only from those in the pretest sample that we could not match to posttest data, following a procedure recommended by James and Williams (2000). This removed common source and method bias between the predictors and the dependent variables by separating them both in time (the data were collected 1 year apart) and in source, as none of the individuals under investigation provided data used in the creation of the contextual variables.

Perceptions of rewards and feedback, education, and information varied significantly between organizational departments (reward and feedback system: $F_{12,794} = 3.40$, $p < .01$; education system: $F_{12,793} = 5.86$, $p < .01$; information system: $F_{12,793} = 9.76$, $p < .01$), suggesting there was an overall culture within departments that was shared or similar across groups. In addition, interrater reliability [ICC(2)] was high, indicating reliability of departmental means (reward and feedback: .64; education: .81; information: .95). In fact, all values were above the .60 level multilevel researchers have identified as necessary to indicate that acceptable levels of mean score reliability exist (Glick, 1985; Ostroff & Schmitt, 1993), thereby justifying aggregation of individual perceptions to the department level. This empirical justification, in addition to the conceptual justification provided above, supports the aggregation procedure we used in this study.

Results

Table 1 shows the means, standard deviations, and intercorrelations at pre- and posttest. The means of all but one of the variables increased from pre- to posttest, indicating a general improvement over time. Table 2 displays the means and standard deviations within each condition at pre- and posttest. The employees who had their work redesigned into semi-autonomous teams showed increases in all three dependent variables and in autonomy, whereas those who stayed in traditional workgroups stayed at roughly the same levels (with the exception of problem solving, where they also increased).

Before testing the hypotheses, we examined responses to the group autonomy scale to determine if the team design intervention affected the proposed causal mechanism. Employees whose work had been redesigned into semi-autonomous teams were significantly higher on this scale at posttest ($M = 3.21$) than those who remained in traditional workgroups ($M = 2.93$, $F_{1,256} = 7.55$, $p < .01$). Because this was a quasi-experiment and employees were not randomly assigned to conditions, it was possible that this result may have been subject to selection bias and may be due to individual differences between employees. Therefore, we also regressed group autonomy on the work design dummy code while controlling for pretest levels of group autonomy. This result was also significant ($\beta = .17$,

TABLE 1

Descriptive Statistics and Intercorrelations Among Study Variables

	Pretest		Posttest											
	M	*SD*	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Work design[a]	—	—	.52	.50	—	.06	−.08	.06	.00	.03	−.05	−.03	−.11	.07
2. Effort	3.43	.97	3.59	.92	.19**	—	.32**	.48**	.21**	.20**	.16**	.25**	.08	.09
3. Skill usage	2.98	.92	3.20	.87	.11	.43**	–	.44**	.30**	.41**	.43**	.47**	.39**	−.09
4. Problem solving	3.18	.78	3.31	.81	.28**	.64**	.61**	—	.30**	.38**	.30**	.29**	.10	.04
5. Group autonomy	3.03	.78	3.07	.83	.17**	.32**	.42**	.53**	—	.33**	.29**	.44**	.09	.01
6. Reward and feedback system	2.41	.93	2.33	.85	.09	.27**	.46**	.42**	.43**	—	.41**	.38**	.15*	−.09
7. Education system	2.68	.85	2.75	.90	.06	.26**	.50**	.42**	.41**	.48**	—	.58**	.24**	−.04
8. Information system	2.70	.81	2.83	.82	.05	.27**	.47**	.42**	.47**	.47**	.58**	—	.35**	−.12
9. Tenure	17.33	10.16	17.50	10.29	−.11	.01	.30**	.15*	.02	.12*	.23**	.26**	—	−.40**
10. Gender[b]	.34	.47	.34	.47	.07	.15*	−.02	−.02	.05	−.06	−.09	−.13*	−.40**	—

Note. *N* ranges between 250 and 258 due to missing data. Pretest correlations above the diagonal; posttest correlations below the diagonal.
[a]0 = *Traditional workgroup structure*, 1 = *Semi-autonomous team structure*.
[b]0 = *Male*, 1 = *Female*.
*$p < .05$, **$p < .01$.

TABLE 2
Pretest and Posttest Means by Condition

		Pretest		Posttest	
		M	*SD*	*M*	*SD*
Traditional workgroups ($N = 125$)	Effort	3.37	.99	3.39	.97
	Skill usage	3.06	.93	3.11	.94
	Problem solving	3.13	.73	3.39	.87
	Group autonomy	3.03	.77	2.93	.88
Semi-autonomous Teams ($N = 133$)	Effort	3.49	.96	3.75	.85
	Skill usage	2.91	.91	3.29	.77
	Problem solving	3.23	.82	3.52	.71
	Group autonomy	3.02	.81	3.21	.75

$t = 2.98$, $p < .01$). Therefore, we proceeded with the hypothesis testing with confidence that the work design intervention successfully increased group autonomy.

The dependent variables displayed moderate positive relationships with each other, ranging from .31 (between effort and skill usage at pretest) to .64 (between effort and problem solving at posttest). These are not so large, however, as to suggest that these measures are redundant with one another. Thus, we tested each of the three performance behaviors in separate hierarchical linear models. The following variables were entered as Level 1 predictors: (a) the score on the dependent variable at pretest, to control for between-subject variance at the time of the pretest, and to avoid the problems associated with difference scores (Edwards & Parry, 1993); (b) the control variables of gender and organizational tenure; and (c) a dummy variable that captured whether the employee's work had been redesigned into a semi-autonomous team. We note that controlling for pretest scores creates a highly rigorous test of the effect of work design and removes many threats to internal validity that plague cross-sectional research designs (Cook & Campbell, 1979). For Level 2, we entered the appropriate departmental context variable in the Level 1 intercept equation and the Level 1 equation for work design slope. Continuous variables (pretest measures, organizational tenure, and departmental context) were grand mean centered, and the categorical variables (gender and the work redesign variable) were uncentered.

Table 3 displays the results of the HLM models. The significant coefficients for the department context variables (γ_{01}) on Intercept 1 (β_0) indicate that context had a main effect on the performance behaviors. Hypotheses 1, 2, and 3 predicted that redesigning work into semi-autonomous teams would have a positive effect on the performance behaviors in the

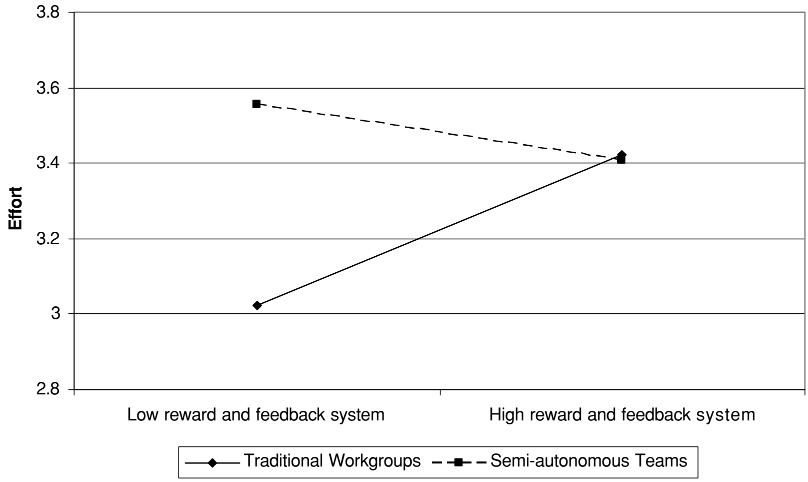
TABLE 3

Hierarchical Linear Models of Effects of Work Design on Performance Behaviors

	Effort			Skill usage			Problem solving		
Variable	Coefficient	*SE*	*t*	Coefficient	*SE*	*t*	Coefficient	*SE*	*t*
For intercept 1, β_0									
Intercept 2, γ_{00}[a]	3.21**	.18	18.32	2.94**	.16	18.31	3.12**	.17	18.78
Department context, γ_{01}[a,c]	1.22*	.43	2.81	.68†	.34	2.02	.65	.37	1.75
Pretest, γ_{10}[b]	.38**	.05	7.19	.37**	.06	6.56	.36**	.06	6.27
Tenure, γ_{20}[b]	.00	.01	.48	.01*	.01	2.01	.01	.01	1.48
Gender, γ_{30}[b]	.20†	.12	1.67	.14	.11	1.33	.02	.10	.23
For work design, β_4									
Intercept 2, γ_{40}[b]	.26*	.10	2.58	.18*	.10	1.95	.39**	.09	4.25
Department context, γ_{41}[b,c]	−1.62**	.57	−2.72	−.72†	.42	−1.73	−1.19*	.38	−3.15

[a]$df = 8$. [b]$df = 240$. [c]The department context variables were reward and feedback systems for the effort model, education systems for the skill usage model, and information systems for the problem solving model.

$^{*}p < .05$, $^{**}p < .01$, $^{\dagger}p < .10$.

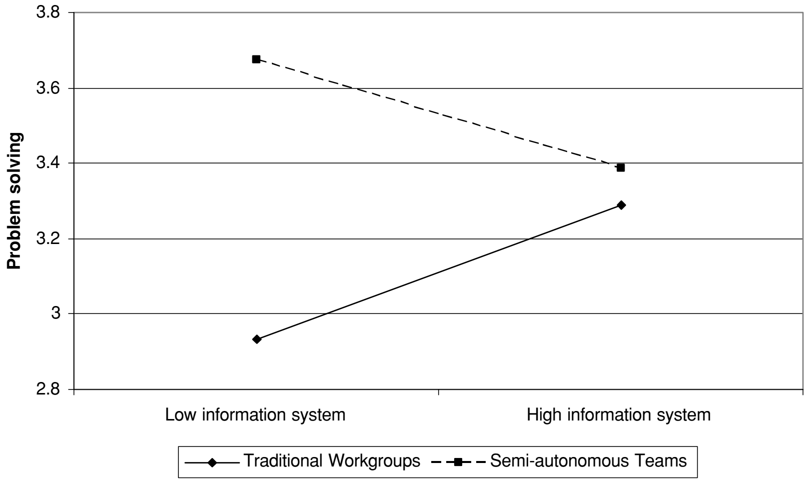


Note: Low and high reflect ±1 standard deviation from the mean.

Figure 2: **Moderating Effect of Reward and Feedback Systems on the Relationship Between Work Design and Effort**

team. All three hypotheses were supported (see Table 3). After controlling for pretest levels, gender, organizational tenure, and accounting for the nesting of employees within departments, the work design intervention significantly increased effort ($\gamma_{40} = .26$, $p < .05$), skill usage ($\gamma_{40} = .18$, $p < .05$), and problem solving ($\gamma_{40} = .42$, $p < .01$). We computed effect sizes by examining the reduction in the Level 1 variance when the work redesign variable was added. The redesign accounted for 3.5% of the Level 1 variance in effort, 1.8% of the Level 1 variance in skill usage, and 9.8% of the Level 1 variance in problem solving. These results suggest that redesigning work into semi-autonomous teams results in a general improvement in the performance behaviors of employees. Because the longitudinal design of this study allowed us to control for pretest scores on the dependent variables, these results provide stronger evidence for the benefits of semi-autonomous teams than previous cross-sectional research.

Hypothesis 4 predicted that the contextual variable of reward and feedback systems would moderate the relationship between the work design intervention and effort. This hypothesis was supported ($\gamma_{41} = -1.62$, $p < .01$). The pattern is consistent with the hypotheses, such that the semi-autonomous team-based design had no effect in departments with effective reward and feedback systems but had pronounced positive effects in departments with poor reward and feedback systems. The nature of the interaction is graphically displayed in Figure 2. Hypothesis 5 predicted that



Note: Low and high reflect ±1 standard deviation from the mean.

Figure 3: **Moderating Effect of Information Systems on the Relationship Between Work Design and Problem Solving**

the contextual variable of education systems would moderate the relationship between the team-based design intervention and skill usage. This hypothesis was not supported ($\gamma_{41} = -.72, p > .05$). Hypothesis 6 predicted that the contextual variable of information systems would moderate the relationship between the team-based design intervention and problem solving. This hypothesis was also supported ($\gamma_{41} = -1.25, p < .01$). The interaction plot is displayed in Figure 3.

One potential alternative explanation for these results concerns changes to department context over time. If the introduction of teams also was accompanied by an improved departmental context, this might account for the observed improvement in performance behavior. To test this possibility, we performed paired sample t-tests on the contextual variables to compare changes from pre- to posttest within each department. Out of the 30 tests (3 tests in each of 10 departments), only 2 significantly changed. This is about what would be expected by chance alone. One department had slightly lower scores on their reward and feedback system at posttest than at pretest, and another department had slightly higher scores on their information system at posttest than at pretest (both $p < .05$). To further rule out this alternative explanation, we ran hierarchical linear models using the posttest contextual variables at Level 2 instead of the pretest ones. The results were almost identical to those with the pretest contextual variables. Thus, changes in departmental context are not responsible for the observed improvements in performance behaviors.

Discussion

There were two main goals of the present study. First, we sought to enhance our understanding of whether a transition from a traditional work-group structure to a semi-autonomous team structure would benefit an organization. By focusing on performance behavior as a more proximal outcome, through a field quasi-experiment we showed that redesigning work into a semi-autonomous team structure produced overall improvements in effort expended, skill usage, and problem solving.

Although this finding might suggest that team-based designs are always beneficial (and hence are not merely a management fashion), the second goal of this research was to explore when an organization is most likely to benefit from the introduction of semi-autonomous team structures. It may be that the overall positive effects we observed are being driven by certain characteristics of the organizational context. Consistent with this explanation, we found the performance behaviors in semi-autonomous team structures only improved when the contextual conditions were relatively poor. Specifically, we found increased effort when there were poor reward and feedback systems and increased problem solving when there were poor information systems. In essence, team designs can substitute for a poor organizational context. When the context is good, there appears to be little reason to go to the expense and effort of implementing team structures. Yet there was a smaller moderating effect of education systems on skill usage. Given the main effect results, this suggests that introducing semi-autonomous team structures will always lead to greater levels of skill usage.

Contributions to Theory and Practice

This research makes a number of contributions to theory and practice. First, it suggests that semi-autonomous team designs are not merely a management fashion but instead are a legitimate administrative technology that can enhance performance behaviors under the right conditions. The results of this study suggest that the key to the appropriate use of team designs lies in understanding the surrounding organizational context. Management scholars and others who may be skeptical of topics that receive a great deal of attention in the popular press may feel somewhat more confident in the validity of semi-autonomous team designs as an efficient administrative technology. Second, this study represents the first direct test of the contextual moderators identified by Hackman (1987). As such, it provides some initial evidence that it is essential to consider elements of the organizational context when developing models of team performance. Although long neglected, this research has shown the benefit of considering organizational reward, education, and information systems when deciding whether to redesign work into semi-autonomous teams.

Third, this research indicates that semi-autonomous team designs may not always be needed. As such, we sound a cautionary note to balance against the generally positive treatments of teams. Our research suggests that contextual factors should be taken into account before semi-autonomous team designs are implemented. Although our study focused specifically on the moderating effects of organizational systems, other factors are also likely to act as moderators. For example, characteristics of the type of tasks employees perform may render semi-autonomous team designs more or less effective. In particular, tasks that have higher degrees of interdependence (Thompson, 1967) should benefit more from a semi-autonomous team design than less interdependent tasks. In addition, work performed in highly dynamic and changing environments will also likely benefit from a transition to team designs. The increase in group autonomy will enable teams to more effectively respond to nonroutine situations and events (particularly if appropriate leadership is in place; Morgeson, 2005), a key principle of sociotechnical systems theory (Cherns, 1978).

Strengths and Limitations

There are several features of this research that enhance our confidence in these findings. First, the quasi-experimental research design is more rigorous then the *ex post facto* designs typically conducted in field settings. Second, studying the phenomenon in a field setting where actual changes were made to the work allowed us to study phenomena that cannot easily be modeled in laboratory settings. Third, controlling for pretest scores on the study variables when testing the hypotheses ruled out many of the threats to internal validity often observed in less rigorous research designs (Cook & Campbell, 1979).

These results, however, have some potential limitations. First, the quasi-experimental design means that employees were not randomly assigned to treatment conditions. This creates internal validity threats that should be addressed before conclusions are drawn. Although it is possible that individuals whose work was redesigned into semi-autonomous teams might be different than those whose work was not redesigned, such selection effects are unlikely to have occurred because the pretest values of the variables were included in the model as covariates. Furthermore, several covariates were examined and found to have no effect. Any maturation effects would likely be equal for those in semi-autonomous team designs and those not in semi-autonomous team designs, and instrumentation and testing effects are unlikely because the measures were taken 1 year apart and the same questionnaire was used. Compensatory rivalry could not have accounted for the fact that those in semi-autonomous team designs improved more than those who were not in team designs. Finally, another potential limitation is the decrease in sample size due to respondents forgetting their matching codes. It may be that those who remembered their matching codes were somehow different than those who forgot their codes. Yet, the attrition bias analysis that we conducted suggested that these groups were similar.

Second, the performance behaviors were all measured with self-reports. Because of this, common method bias might be an alternative explanation for the findings. One possibility is that there might be a demand characteristic such that individuals who received the intervention "understand" that semi-autonomous teams are great and thus rate the performance behaviors higher, whether they are or not. However, any common method bias will not have affected the interaction hypotheses because (a) the context measures are methodologically separate and (b) interaction effects lessen common response bias concerns (Evans, 1985).

Another possible way that common method bias might be operating is through the effect of the intervention on satisfaction and dissatisfaction. It might be the case that receiving the intervention results in greater satisfaction and it is the resulting positive affect that drives changes in performance behavior ratings. Alternatively, there might be a reaction effect for those who did not receive the intervention, such that these individuals experience dissatisfaction, which results in lower performance behavior ratings. Fortunately, we can directly test this possibility. Although not reported in this manuscript, we also collected data on job satisfaction. When we compared the two work design groups at the posttest, we found no differences in job satisfaction. This indicates that affective reactions are not responsible for observed differences in performance behaviors.

Third, self-reports of the performance behaviors (effort, skill usage, and problem-solving) are clearly not the same thing as performance results (e.g., objective performance data). Unfortunately, we were simply unable to collect more objective performance results outcomes. In fact, we specifically and repeatedly pressed the issue of objective performance measures with organizational representatives. They indicated that productivity was influenced by so many things (e.g., size of production runs, number of changeovers needed, quality of raw materials, and so on) that the objective numbers were not comparable across teams and departments. It is possible that these performance behaviors might not translate into performance results, in part because performance behaviors are under the direct control of the employee, whereas performance results often depend on factors outside the control of the employee (e.g., available resources, equipment breakdowns, and so on; Borman, 1991). Future research should investigate the extent to which a transition to semi-autonomous team structures impact performance results.

Fourth, the study was conducted within a single organization and, thus, may not be generalizable to the entire population of organizations. Clearly, additional research utilizing rigorous experimental or quasi-experimental research designs like ours is needed. Our results, however, suggests that large organizations should consider the systems found within their subunits (departments, SBUs, etc.), rather than simply examining an omnibus measure of organizational context.

Fifth, because our posttest measurement occurred only a year after the work redesign, the effects we observed may reflect "transitional" as opposed to "fully implemented" effects. Wall et al. (1986) conducted one of the few studies that actually assessed the effects of work redesign at both 6 months after the redesign and at 30 months after the redesign. They found that in terms of perceived autonomy and intrinsic job satisfaction, both increased after the redesign, but there were no differences between the increase found at 6 months and that found at 30 months. Thus, in this study there was no transitional period. Morgeson and Campion (2002) also evaluated the impact of a work redesign 1 and 2 years following redesign. Results were consistent across the two evaluation periods, again suggesting no transition effects. Finally, Campion and McClelland (1993) conducted a short (several months) and long-term (2 years) job redesign evaluation. They found that the costs and benefits of work redesign changed over time, suggesting perhaps some differences will emerge over time. It is impossible to know if we would have observed stronger or different effects with a longer follow-up. Future research should employ extended follow-up measurements as done in other redesign research to directly investigate this issue.

Conclusion

In this paper, we have sought to examine the impact of transitioning from a traditional workgroup structure to a semi-autonomous team structure. Despite the popularity of teams, there have been relatively few quasi-experimental field investigations examining such a transition. We found that redesigning work into a semi-autonomous team structure produced overall improvements in effort expended, skill usage, and problem solving. Yet in two instances, these positive effects depended on the nature of the departmental context. Specifically, we found increased effort when there were poor reward and feedback systems and increased problem solving when there were poor information systems. This indicates that team designs can substitute for poor contextual conditions and suggests that when the contextual conditions are good, there is little reason to implement team-based structures.

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