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Production teamworking: The importance of interdependence and autonomy for employee strain and satisfaction

Christine A. Sprigg, Paul R. Jackson and Sharon K. Parker

ABSTRACT

A UK manufacturer introduced a common model of teamworking which achieved quite different performance results in wire-mills and roperies. Survey data (n = 231) showed higher job-related strain and lower job satisfaction in the wire-mills, where teamworking was not a success. Findings indicated that the differences in employee well-being could be accounted for by contrasting levels of process interdependence in the two production areas. Teamworking was a success in the roperies where process interdependence was high, but not in the wire-mills where there was a mismatch between this production process characteristic and a team-based form of work organization. Interactions between interdependence and autonomy were also found, such that higher autonomy had a positive impact only for those working in low interdependence processes. The unintended consequence of teamworking under low interdependence is to create winners and losers, as individual team-members take on responsibilities of the team as a whole.

KEYWORDS

employee strain ▪ individual and collective autonomy ▪ interdependence ▪ teamworking

Introduction

Teamworking is an increasingly common form of work design, both in white-collar and in production environments. Gordon (1992) estimated that 80 percent of US organizations with 100 or more employees use teams in some way; and Osterman (1994) found that self-directed teams were present in 54 percent of over 600 leading US enterprises surveyed. A recent longitudinal study of 564 British manufacturing companies (Waterson et al., 1997) found that 55 percent had made at least moderate use of team-based working during the previous six years. Despite this popularity, performance benefits do not consistently meet expectations (Waterson et al., 1997), and many team ventures within US organizations have been reported as failures (Lawler, 1986, 1988; Saporito, 1986; Verespej, 1990; Walton, 1985).

In seeking to understand inconsistencies in the results of teamworking initiatives, it is necessary to consider not just the initiative itself but also the context within which it is set, since McGrath (1984) among others has argued that findings may be very context sensitive. For production teams of blue-collar workers, such as those which form the focus for the present study, work designs in industrial settings are often determined, at least in part, by features of the technology and other aspects of the production process (Slocum & Sims, 1980). The conceptual framework for this study is adapted from that used in previous studies (Jackson & Martin, 1996; Jackson & Mullarkey, 2000; Parker et al., 1998) for evaluating the impact of manufacturing initiatives on employee well-being. According to the framework, salient characteristics of production processes have an impact on the nature of shopfloor work, and work design in turn influences employee well-being such as employee strain and job satisfaction.

One implication of the framework is that a key to well-being is the fit between characteristics of the production process and the chosen form of work design. This implies a contingency approach to the consequences of work design (Cummings & Blumberg, 1987; Wall & Jackson, 1995), such that the same form of work design would have different consequences for productivity and employee effectiveness depending upon the production context. Thus, production process characteristics can be seen as moderators of the relationship between work design and outcomes, and two such moderators are shown in Figure 1: production uncertainty and interdependence. The first of these, production uncertainty, describes the extent to which there is variability in raw material properties or machine characteristics. In a study conducted within electronics assembly, Wall et al. (1990) and Jackson and Wall (1991) demonstrated substantial productivity benefits of enhanced individual autonomy for production operators, but only for systems with

substantial production uncertainties. There was no gain from enhanced autonomy for low variance systems which ran continuously with little need for periodic adjustments to deal with product changes or machine malfunctions.

The focus of the current paper is on interdependence as a second characteristic of the production process which plays an important part in defining appropriate forms of work design. Interest in interdependence dates back to the late 1960s when Thompson (1967) argued that the appropriate form of work organization reflects the extent to which individuals and departments are dependent on each other's resources or outputs in order to accomplish their own work. Thompson described this characteristic using the term technological interdependence, and argued that specific technologies created distinctive forms of interdependence and thus required different work designs in order to co-ordinate work activities. For example, assembly-line work was characterized as inherently sequentially interdependent; while other forms of production process were described in terms of reciprocal and pooled interdependency.

Since then, the concept has been considered in a number of different ways in the literature, and has variously been termed work-flow integration (Pugh et al., 1968), coupling (Corbett, 1987) and task interdependence (Hrebiniak, 1974). Common to all of these is the idea of interdependence as the extent to which 'group members must interact and depend on each other in order for the group to accomplish its work' (Guzzo & Shea, 1992: 296; see also Kiggundu, 1983; Mohr, 1971; Van de Ven et al., 1976; Wageman, 1995).

Having considered interdependence as a characteristic of production processes, we now turn our attention to a second element of the research framework, the associated form of work design. A central assumption of the framework is that the relationship between production processes and work designs is not a deterministic one: system designers have choices in the form

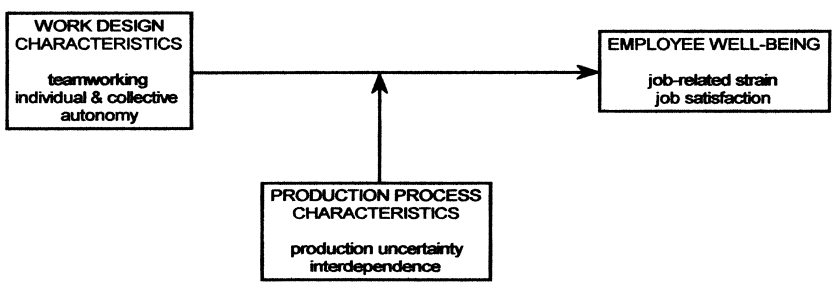

Figure 1 Conceptual framework for links between production process characteristics, work design and employee effectiveness

of work design associated with a specific process (though choices may be highly constrained). Thus, Wageman (1995: 146–7) suggests: 'task interdependence is a structural feature of work, but tasks can be designed to be performed at varying degrees of interdependence'. According to sociotechnical systems principles (Klein, 1991; Susman, 1976), an appropriate form of work design would be one which grouped interdependent tasks together in order to maximize the autonomy of the work group and minimize the need for decision-making across the boundary defining the work group. Thus, it is commonplace that team-based work designs are recommended in the literature for highly interdependent production processes (e.g. Hackman, 1987; Sundstrom et al., 1990). Indeed, interdependence is often taken as a key prerequisite which distinguishes teams from groups (Katzenbach & Smith, 1993; Salas et al., 1992); although Guzzo (1986) regards the two terms as largely synonymous in organizational settings.

Campion et al. (1993) in their review of models of team effectiveness argued that interdependence is 'implicit in all the models' (1993: 826), and there is some limited empirical evidence linking this aspect of work design to positive effects on employees. Wong and Campion (1991) found that interdependence among tasks in the same job increased motivation; and Kiggundu (1983) found positive relationships between team-based forms of work design and the employee outcomes of motivation and job satisfaction.

However, based on the framework in Figure 1, the validity of claims for benefits from team-based work designs would depend upon the appropriateness of the work design for the structural properties of the production process. In a laboratory study, Saavedra et al. (1993) found higher performance for student groups where there was congruence between the interdependence characteristics of the task and the design of the work group itself. While the external validity of this study is arguable (it clearly does not capture the many contingencies that real-world organizational groups face), its findings are supported by results from a quasi-experimental field study by Wageman (1995). Better performance and team-member satisfaction were found where the interdependence of the task matched the design characteristics of the work-group; so-called 'hybrid groups' performed least well. In the light of these studies, we would expect positive outcomes from team-based forms of work design only where the production process is highly interdependent, leading to a good fit between production process and work design.

The opportunity to test this expectation came from contact with a manufacturer of wire and rope, where the same team-based form of work design was implemented in locations of contrasting production process characteristics: wire-mills and roperies. Management reported that performance benefits from teamworking were limited in the wire-mills compared

with the success achieved in the roperies, and they felt that employee morale and satisfaction were lower in the wire-mills. We set out to assess these anecdotal reports more precisely, and to test the hypothesis that contrasting levels of work interdependence could account for the differences in employee well-being between wire-mills and roperies. We predicted lower employee strain and higher satisfaction where there is a good fit between the degree of interdependence of the production process and a team-based form of work design.

Interdependence and autonomy

The second work design characteristic that we consider in this paper is autonomy, both individual and collective. In an early study, Kiggundu (1983) considered individual autonomy and interdependence in a sample of office employees in a life assurance company, and found strong main effects of both autonomy and interdependence on job satisfaction, but no evidence of interactions between the two. The more control employees had over their tasks, such as when and how they perform them, the greater their satisfaction regardless of the extent of the level of interdependence in their jobs. Liden et al. (1997) have pointed out that, since then, contextual factors such as interdependence have been largely neglected in studies of autonomy, despite suggestions that such factors may be critical in explaining inconsistencies in findings on relationships between collective autonomy and team effectiveness (Cordery et al., 1991; Goodman et al., 1987; Pearce & Ravlin, 1987).

Furthermore, it is important to consider both individual and collective autonomy. While there is widespread evidence of positive impacts of individual autonomy on both employee job satisfaction and job-related strain (see Parker & Wall, 1998), interventions often emphasize collective autonomy by granting control over work-related decisions to teams of people who work together to achieve task goals (e.g. Wall et al., 1986). As a consequence, autonomy needs also to be considered at the level of the work-group (Klein, 1991), and evidence relating group autonomy to outcomes is sparse and inconsistent. Wall et al. (1986) found that the implementation of autonomous work-groups led to lasting effects on employees' intrinsic job satisfaction, only temporary effects on extrinsic satisfaction, and no effects on employee strain. Liden et al. (1997) found an interaction between collective autonomy and interdependence in a study of groups drawn from a service organization and the headquarters of a manufacturing organization, but collective autonomy was measured by managers' ratings of the group as a whole and their dependent variable was group performance rather than satisfaction or well-being. Campion et al. (1993), using group-level data (this time aggregated from individuals' ratings), found that self-management (i.e. collective

autonomy) was significantly related to group productivity, but only weakly to employee satisfaction. The latter relationship is problematic, however, because the satisfaction variable was aggregated across all group members, while the other variables were aggregated only across a subset of group members (typically five per group). Moreover, they did not consider the possibility of an interaction between collective autonomy and interdependence. In general, therefore, there is very little consistent evidence to enable predictions to be made about how collective autonomy and interdependence might work together in influencing employee well-being.

What are the implications for individuals' autonomy within groups which have been given collective autonomy over work tasks? Several authors (Cummings; 1978; Hackman, 1977; Pearce & Ravlin, 1987) have argued that dysfunctional performance outcomes result from the imposition of collective autonomy within a team-based form of work design on to employees who work in low interdependence production settings. Where team-members work independently of one another, individual rather than collective autonomy over work tasks is likely to be more effective: there are costs rather than gains in involving others in decisions that are of no consequence to them in the completion of their own tasks. While the performance of the group as a whole is likely to suffer, therefore, there may still be benefits to well-being which accrue to those individuals within low interdependence production settings who are given authority by the team as a whole to make decisions for which the team is collectively accountable. Thus, we might expect there to be a positive relationship between individual autonomy and employee outcomes within low interdependence production settings.

Aims of the study

In summary, the study has two aims. The first aim is to examine the consequences of implementing a common form of teamworking in the wire-mills and roperies of the same organization where the production processes in these locations have contrasting levels of interdependence. We predict that well-being will be poorer (higher strain and lower satisfaction) for those who work in wire mills than for those working in roperies, and that this difference can be accounted for by differences in interdependence between the two production settings (hypothesis 1). The second aim is to examine the joint effects of interdependence and autonomy (assessed at the individual and the collective level); in particular, interdependence as a moderator of the relationship between autonomy and employee well-being.

Method

Organizational setting

The research was conducted in five UK sites of a world-leading manufacturer of specialist wire and wire rope. The company had recently implemented shopfloor teams in all its sites. A common model of teamworking was planned for all production sites: teams would have a broader range of responsibilities, production scheduling would increasingly become part of the responsibility of teams themselves, and the 'command-and-control' supervisory role was to be replaced by a facilitatory team-leader role. In both wiremills and roperies, teams were planned to exist in a permanent form, with a team-leader selected by the management. Teams were composed of between eight and 12 employees (with the marginally larger teams in the roperies).

Despite using a very similar mode of implementation of a common model of teamworking, the initiative had mixed success. Benefits of the initiative were confined largely to the roperies as the work designs of teams evolved in different ways across the company. From both anecdotal and qualitative information (collected by the researchers from meetings and interviews with team-members, managers and supervisory staff), there was a consensus that employees in the roperies were embracing the idea of teamworking and making significant productivity improvements (for example, the rope teams on one site made such productivity gains that their internal suppliers of feed-wire could not keep up with them).

The rope-making process

Rope teams were designed as product-based teams composed of employees from each part of the production process. Personnel required to make a whole product were grouped together into a team made up of stranders, winders and closers (in the most advanced site, teams also included maintenance personnel). The extent of the product-based structure was shown in the pilot site where teams were given names according to the product group they manufactured, e.g. the Cranemen, the Fishermen. In other roperies, all members of a shift constituted a team.

The manufacture of rope begins with spools of wire on bobbins, and it involves three steps: winding, stranding and closing. The finished product consists of many individual wires wound around a number of cores in order to maximize the strength of the rope. *Winding* involves transferring wire from the bobbins on which it is delivered to the ropery on to bobbins suitable for use in the second stage, *stranding*. A stranding machine is fed by multiple single strands of wire (up to 32), which are wound together around

a core. The last stage, *closing*, takes multiple strands and winds them together to make a multi-core rope.

Setting up a rope-making machine involves threading up many strands of wire each from its own spool, and set-up times can be drastically reduced by several people working together on this part of the production process provided that each of them has a crane available for lifting the bobbins of wire. During normal working, one person can monitor several machines; though reacting to wire breaks is also a part of the production process that benefits from people working together. If individual strands of wire break, they have to be replaced quickly since many customers will not tolerate welds within a length of rope because they believe that it will reduce the strength of the finished rope.

It is clear from the nature of the production process that interdependence is high, and there is obvious value in ropery employees working together to set up and operate the machinery. This is especially true of the larger machines where as many as seven employees can co-operate together and thereby considerably reduce machine set-up times.

The wire-drawing process

The wire-drawing process involves pulling a single strand of wire through a number of successively smaller dies in order to achieve a target diameter, and the finished wire is then respooled. Workers are responsible for running from one to three machines; and there is no benefit in working together to set up machines since only one strand of wire is involved. Wire teams were organized in a more process-oriented manner: operators running similar machines (drawing wire down to the same dimensions) were grouped together and called a team. Although members of some teams were located in reasonably close physical proximity to each other, the size of the machines and the noise generated by them severely constrained operators from co-operating with each other as management had wished. In other cases, wire-drawers allocated to the same team worked over 50 metres away from each other; and it was impractical to expect meaningful co-operation between them since there was no opportunity for someone in the team needing help to communicate with others.

From our discussions with shopfloor employees and observations of both types of work, it was clear that the work process in rope-making is much more interdependent than that in wire-drawing. Therefore, interdependence is both related to the technological context (machine layout on the shopfloor) and to the nature of the tasks that employees carried out.

Procedure and sample

Preliminary semi-structured interviews were conducted with a sample of senior managers, middle managers and shopfloor employees from four sites; group discussions were held with wire-drawing and rope-making teams on three sites; and shopfloor representatives were observed at work on four sites. On the basis of this qualitative work, a survey questionnaire was devised by the researchers in collaboration with a group of 12–15 employee representatives drawn from all sites and from all levels within the company (including trade union representatives). The researchers administered questionnaires in group sessions on each site, during which the purpose and value of the survey were explained and any queries dealt with. Confidentiality of individual responses was guaranteed.

Survey data were gathered from employees across the company as a whole (n = 756; representing a 70 percent response rate). This paper uses data only from wire-drawers and rope-makers (n = 266; of which 231 employees provided complete data on the variables used in this paper, n = 93 wire-drawers and n = 138 rope-makers). The teams in wire-drawing and rope-making did not significantly differ with respect to gender or company tenure. They did differ significantly on age (t = 7.50, p < .01), with wire-drawers older (mean = 39.51 years) than rope-makers (mean = 35.38 years).

Measures

The questionnaire was part of a broader evaluation of the organization which included biographical information, and measures of a variety of work design characteristics and employee attitudes. We describe here the measures relevant to the aims of this study.

Work interdependence

Work interdependence was assessed using a six-item scale adapted from Campion et al. (1993), which includes items relating to task, goal and feedback interdependence. The six items were: 'Members of my team have skills and abilities that complement each other'; 'I cannot get my tasks done without information and materials from other members of my team'; 'Other members of my team depend on me for information or materials needed to perform their tasks'; 'My work goals come directly from the work goals of the team'; 'Everything I do is related to the goals of my team' and 'Feedback about my performance in my job comes primarily from information about how well my team is performing'. A five-point scale was used, with response

alternatives: 'strongly disagree', 'disagree', 'neither agree nor disagree', 'agree', 'strongly agree'. Internal reliability (Cronbach's alpha) was 0.72.

Individual autonomy

Individual autonomy was assessed using two scales. *Task control* (10 items) was assessed by combining the timing and method control scales developed by Jackson et al. (1993) primarily for production environments. Timing control relates to the extent to which employees had control over when they did their work (e.g. 'Do you decide on the order in which you do things?'); while method control relates to how they did their work (e.g. 'Can you decide how to go about getting your job done?'). The five-point scale had response alternatives: 'not at all', 'just a little', 'moderate amount', 'quite a lot' and 'a great deal'. The scale had an internal reliability of 0.82. A seven-item scale of *individual role breadth* was adapted from Mullarkey et al. (1995) to assess the extent to which the role of employees allowed them influence over broader aspects of their work and were involved in decisions which affected the performance of their primary tasks. Items covered, for example: workload, the physical layout of the work area, the selection of new colleagues, goals and targets for the team, and long-term plans for their part of the business. The five-point scale had response alternatives: 'not at all', 'just a little', 'moderate amount', 'quite a lot' and 'a great deal'. Since the scale is simply a checklist of role elements, calculation of a reliability coefficient is inappropriate.

Collective autonomy

Collective autonomy was assessed using two scales. *Collective task control* was assessed by the scale used by Jackson and Mullarkey (2000) who adapted the individual-level task control items to refer to the team rather than the individual. An example item was: To what extent – 'does your team decide on the order in which work is done?'. The internal reliability of the scale was 0.77. *Collective role breadth*, the extent to which teams had influence and involvement over broad aspects of their work, was assessed using a six-item scale, adapted from Little (1989). Items included 'Are team-members themselves involved in making decisions about setting goals and targets?', 'Are people in your team asked for their views when decisions are made about the job?' and 'Do team-members have the authority to discipline other team-members?'. The five-point scale had response alternatives: 'not at all', 'just a little', 'moderate amount', 'quite a lot' and 'a great deal'. Internal reliability was 0.77.

Job-related strain

A 14-item measure was used to assess job-related strain, by combining scales of job-related anxiety and job-related depression developed by Warr (1990). Respondents were asked how often during the past month their job had made them feel (for example) tense, miserable, happy, relaxed. A five-point response scale was used, with response alternatives of: 'never', 'occasionally', 'some of the time', 'most of the time', and 'all the time'. Internal reliability was 0.86.

Job satisfaction

This was assessed using an 18-item scale based on that developed by Warr et al. (1979), which includes aspects intrinsic to the job (such as chance of promotion, freedom to choose own method of working and recognition for good work) and also aspects that are extrinsic (including pay, hours of work and management style). Respondents were asked to rate each job aspect on a seven-point scale: 'extremely dissatisfied', 'very dissatisfied', 'moderately dissatisfied', 'not sure', 'moderately satisfied', 'very satisfied', 'extremely satisfied'. Internal reliability was 0.91.

Results

Means, standard deviations and correlations among variables used in the study are shown in Table 1. A number of features of the table are of interest. Not surprisingly, the four measures of aspects of autonomy are correlated, though not so highly as to warrant combining them into a single index. There are also significant correlations between the well-being measures, with job satisfaction negatively associated with strain. Interdependence is positively correlated with all four autonomy measures, reflecting the way in which the boundaries of team-members' roles have been extended to allow them greater autonomy over interdependent tasks and work processes. Finally, there are significant associations between both interdependence and autonomy and the two well-being measures. To test the study hypotheses, parallel hierarchical regression analyses were performed for each dependent variable separately.

Means and the results of significance test comparisons between wire team-members and rope team-members on major variables are presented in Table 2. Rope and wire were compared on self-reported work interdependence, in order to confirm our observations indicating that the rope-making process involves higher interdependence (see Table 2). A significant difference

Table 1 Means, standard deviations and correlations among variables

	Mean	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Production process: wire vs. rope	1.60	0.49	–							
Work interdependence	3.32	0.70	.53**	–						
Individual autonomy										
Task control	3.07	0.95	.27**	.32**	–					
Role breadth	1.89	0.52	.30**	.39**	.52**	–				
Collective autonomy										
Task control	2.93	0.99	.40**	.47**	.55**	.39**	–			
Role breadth	2.09	0.79	.28**	.41**	.36**	.48**	.59**	–		
Job-related strain	2.91	0.71	–.13*	–.36**	–.23**	–.23**	–.24**	–.20**	–	
Job satisfaction	3.91	0.99	.19**	.47**	.20**	.28**	.34**	.41**	–.59**	–

*$p < .05$; **$p < .01$.

was found in the predicted direction, t (229) = 8.79, $p < .001$. As expected, rope-makers (mean = 3.63; SD = 0.48) reported significantly greater work interdependence than wire-drawers (mean = 2.87; SD = 0.73). Rope-makers also reported significantly higher levels of task control and role breadth at both the individual and collective level ($p < .001$). Significant differences were found between the two production processes for the two dependent variables; rope-makers reported lower levels of job-related strain and greater job satisfaction than their wire-drawing counterparts.

The first aim of the study was to examine the importance of interdependence in accounting for these differences between groups in employee well-being. Hypothesis 1 stated that employee well-being would be poorer for those employees in teams who work on non-interdependent tasks and in a physical environment that limits opportunities for co-operation. By contrast, employees working on interdependent tasks and in an environment that complements task interdependence would be expected to experience positive outcomes as a result of teamworking. In other words, the observed difference in the measures of employee well-being between the two production processes would be accounted for by differences in their reported interdependence. This would be indicated by a significant regression weight for production process at step 1, which becomes non-significant when interdependence is added at step 2.

Results of hierarchical regression analyses for each dependent variable

Table 2 Means and standard deviations for study variables and results of group comparisons

	Wire-mills (n = 93)		*Roperies (n = 138)*		
	Mean	*SD*	*Mean*	*SD*	p
Work interdependence	2.87	0.73	3.63	0.48	**
Individual autonomy					
Task control	2.76	0.96	3.28	0.90	**
Role breadth	1.49	0.44	1.78	0.56	**
Collective autonomy					
Task control	2.44	0.99	3.26	0.84	**
Role breadth	1.82	0.65	2.27	0.83	**
Job-related strain	3.02	0.82	2.83	0.61	*
Job satisfaction	3.68	1.05	4.07	0.93	**

*$p < .05$; **$p < .01$.

Table 3 Results of hierarchical regression analyses of job-related strain for each autonomy scale separately (n = 231)

			Task control		*Role breadth*	
	Step 1	*Step 2*	*Step 3*	*Step 4*	*Step 3*	*Step 4*
Step 1						
Wire vs. rope	–.14*	.07	.11	.12	.07	.08
Step 2						
Interdependence	–	–.40***	–.35***	–.35***	–.37***	–.35***
Step 3						
Collective autonomy	–	–	–.03	–.05	–.03	–.03
Individual autonomy			–.05	–.10	–.05	–.08
Step 4						
Collective autonomy × interdependence	–	–	–	–.01	–	–.07
Individual autonomy × interdependence	–	–	–	.16*	–	.20**
R-squared change	–	.11***	.02	.02*	.00	.03**

*p < .05; **p < .01; ***p < .001.

Table 4 Results of hierarchical regression analyses of job satisfaction for each autonomy scale separately (n = 231)

			Task control		*Role breadth*	
	Step 1	*Step 2*	*Step 3*	*Step 4*	*Step 3*	*Step 4*
Step 1						
Wire vs. rope	.19**	–.09	–.12	–.13	–.11	–.12
Step 2						
Interdependence	–	.52***	.42***	.41***	.42***	.41***
Step 3						
Collective autonomy	–	–	.18*	.18*	.27***	.28***
Individual autonomy	–	–	–.02	–.03	–.00	.01
Step 4						
Collective autonomy × interdependence	–	–	–	–.02	–	–.01
Individual autonomy × interdependence	–	–	–	–.08	–	–.09
R-squared change	–	.19***	.02*	.01	.05***	.00

*p < .05; **p < .01; ***p < .001.

are reported in Tables 3 and 4. The first step was to enter production process (wire vs. rope), and this simply repeats the *t*-test comparison reported in Table 2, with a significant production process effect for both dependent variables. At the second step, work interdependence was entered and two aspects are of interest. First, we consider whether interdependence is a significant predictor of employee well-being and findings are strongly supportive of this conclusion for both dependent variables (for job-related strain, *beta* = –0.40, $p < .001$; for job satisfaction, *beta* = 0.52, $p < .001$).

Second, hypothesis 1 is based on the proposition that it is the contrasting interdependence between the two production processes that is responsible for the observed differences in employee well-being. The results in column two show strong confirmation for the hypothesis for both dependent variables. For job-related strain, the regression weight drops from –0.14 ($p < .05$) to 0.07 (NS); and for job satisfaction, the regression weight drops from 0.19 ($p < .01$) to –0.09 (NS). In neither instance is the production process variable still significant after work interdependence is added as a predictor. We conclude that the observed differences in employee well-being between the two production processes can indeed be accounted for by contrasting levels of work interdependence.

The second aim of the study was to investigate interactions between work interdependence and both individual and collective autonomy in predicting employee well-being. Given that both narrow and broad aspects of autonomy were measured (task control and role breadth respectively), this involves two separate moderated regression analyses for each dependent variable. Results are reported in columns 3 and 4 of Tables 3 and 4.

At step 3, both individual and collective autonomy were entered, and then product terms were included at step 4 as an interaction test. Having tested for the presence of an interaction between work interdependence and autonomy, the next step was to establish whether the interaction takes the predicted form. Following procedures recommended by Jaccard et al. (1990), the fitted regression equation for autonomy was calculated for several levels of work interdependence separately: at the mean, and one SD above and below the mean. All these analyses were repeated controlling for both site and age; and the pattern of findings was almost identical (details are available from the authors on request). Results related to the second aim of the study will be described for each dependent variable separately. Table 5 reports simple effect tests related to each significant interaction: the regression coefficients (and their significance level) for autonomy at a number of levels of interdependence.

Table 5 Regression coefficients for each significant interaction (simple effect tests), at different levels of interdependence

	Level of interdependence		
	-1_{SD}	*Mean*	$+1_{SD}$
Job-related strain			
Individual task control	–0.19**	–0.09	0.01
Individual role breadth	–0.19**	–0.06	0.08

**$p < .01$

Job-related strain

There is little evidence for main effects of autonomy on job-related strain: none of the regression coefficients is significant at either step 3 or step 4. Turning to the tests of interactions at step 4, both measures of individual autonomy show significant interactions: for task control (column 3), *beta* = 0.16, $p < 0.05$, accounting for 2 percent of the variance; and for role breadth (column 4), *beta* = 0.20, $p < 0.01$, accounting for 3 percent of the variance. The form of the fitted models (Table 5) is illustrated for individual task control in Figure 2. There is a significant negative relationship between job-related strain and both autonomy measures at low levels of interdependence; while no interactions were found for either measure of collective autonomy.

Job satisfaction

The pattern of findings for job satisfaction is quite different from that found for the strain measure. No significant interactions between autonomy and interdependence were found for task control and role breadth at either the individual or the collective level. Furthermore, no main effects were found for individual autonomy; while significant main effects were found for both collective autonomy measures. For task control, *beta* = 0.18, $p < .05$, and for role breadth, *beta* = 0.28, $p < .001$. Higher collective autonomy is associated with more job satisfaction independent of the level of interdependence.

Discussion

The impetus for this study was the uniform application of a common model of teamworking within an organization's manufacturing sites and the observation of relative success of the endeavour in roperies and lack of success in

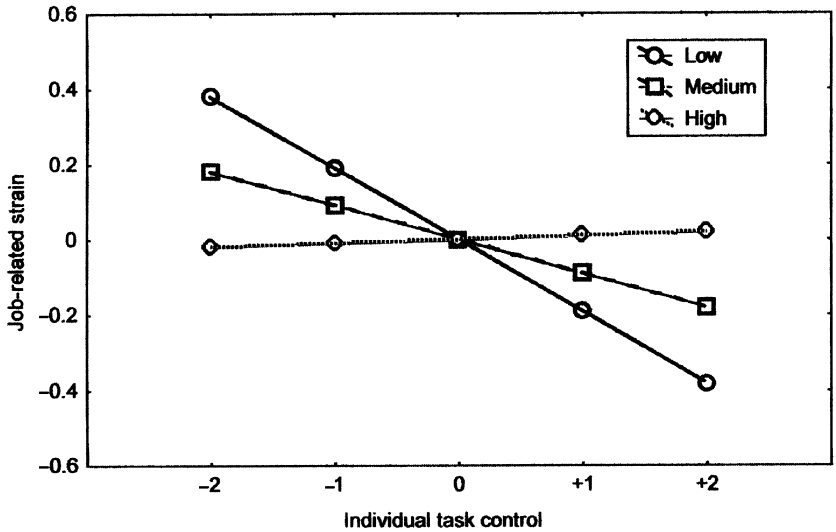

Figure 2 Form of the fitted model relating individual task control to job-related strain at differing levels of interdependence

wire-mills. The first aim of the study was to assess the extent to which there were differences in employee strain and satisfaction between the two production processes, and whether such differences could be accounted for by the process characteristic of interdependence. Findings show strong support for this proposition. For both dependent variables, the significant regression weight associated with production process became small and non-significant when interdependence was added; and interdependence itself was a substantial predictor of both strain and job satisfaction. These findings support the key proposition of the framework in Figure 1 and previous literature which posits the contextual specificity of work design interventions. Teamworking brought production benefits in roperies and was also associated there with benefits in terms of employee strain and satisfaction. By contrast, the production process in wire-mills was one which required employees to work largely independently of each other, and there were no discernible gains from co-operative working arrangements. The result would appear from these findings to be one of higher employee strain and lower job satisfaction for those working in the wire-mills.

Interdependence is a complex construct, and the term has been used in a number of ways in the literature: to describe technologies, production processes and forms of work design. This diversity in application of the term has led to confusion and difficulty in combining results from different studies.

We use the term here to characterize the extent to which different parts of a production process are dependent upon each other in order to accomplish tasks. We apply the term teamworking to a specific form of work design implemented within a production environment. On this logic, it is entirely possible to force a team-based form of work design on to a process with non-compatible characteristics (indeed, this is what the organization described here actually did). Similarly, it is possible to organize work on an individual basis within an interdependent process environment. By distinguishing clearly between characteristics of the production process and of the form of work design implemented within that context, we achieve a degree of conceptual clarity not always present in the literature.

The second aim of the study was to examine the link between autonomy and interdependence. The results may be summarized quite simply. There were main effects of collective autonomy (and no interactions) for job satisfaction: individuals reporting higher levels of collective autonomy were more satisfied. By contrast, significant interactions between interdependence and individual autonomy were found for job-related strain. The form of these interactions is that a significant negative relationship between individual autonomy and strain was found only under conditions of low interdependence.

The positive effects of collective autonomy for job satisfaction in high interdependence conditions are not particularly surprising, since they are consistent with the view that this is the appropriate setting for implementing teamworking and giving collective control to the group. The study showed that higher collective autonomy was associated with greater job satisfaction for production employees, regardless of their degree of task interdependence. Certainly, it is not surprising that employees in highly interdependent settings are more satisfied when the team's capability to make autonomous decisions is high. However, it is somewhat more intriguing to speculate why collective autonomy is associated with greater satisfaction in situations even where interdependence is low.

One potential explanation relates to the context within which the study was conducted. The teamworking initiative had been extensively promoted and marketed throughout the company, with the likely result that collective rather than individual autonomy became a highly salient work characteristic. Where collective autonomy was delivered as promised, employees felt better about their jobs and the company; but where it was not forthcoming and supervisors retained control over work tasks and scheduling this led to unmet expectations, and it would not therefore be surprising for employees to report greater job dissatisfaction under such circumstances. This explanation accounts for the finding that there was no independent association in the regression analysis between individual autonomy and job satisfaction: in the

context of a teamworking initiative, individual autonomy is less salient than collective autonomy as a work design characteristic. Note that we are able to reach this conclusion only because both collective and individual autonomy have been measured, and included in multivariate analyses. The various measures of autonomy are related, and it is only by including both conceptual levels that we can distinguish the relative contribution of autonomy for the work-group from the contribution of individuals within the group. Had only individual autonomy been assessed, as is usually the case in studies of this kind, our conclusions concerning job satisfaction would have been very different.

We turn next to the finding of interactions between interdependence and individual autonomy. Although previous studies (e.g. Liden et al., 1997) have used performance as an outcome and found plausible relationships between autonomy and interdependence, we found no evidence for this when strain and satisfaction are outcomes. While collective autonomy gives satisfaction benefits to all regardless of what kind of production process, the benefits of individual autonomy are very specific – they apply to strain and not to job satisfaction, and they occur only in low interdependence settings. It would obviously be useful in future studies to consider changes in performance indices as well as the measures used here, since it is plausible that what is costly to employees in terms of added strain is also costly in terms of production.

Our findings imply that imposing teamworking in an environment unsuited to it engenders winners and losers: attempts to achieve real collective autonomy here proved to be difficult or impossible, and it would appear that autonomy was 'hijacked' by individuals within work-groups who themselves derive benefit from enhanced autonomy. In other words, the organization sought to divest control previously exerted by supervisors on to work-groups collectively; but the effect within low interdependence settings was merely for decisions to be taken by individuals within teams on behalf of the group as a whole (thus merely substituting for the supervisor). Our findings are that higher individual autonomy for these individuals is associated with lower job strain. This is consistent with the idea that job control reduces strain by allowing employees to manage demands in their work environment more effectively (Karasek & Theorell, 1990; Wall & Jackson, 1995): 'much of the energy aroused by the job's stressors ("challenged") is translated into direct action – effective problem solving – with little residual strain to cause disturbance' (Karasek, 1997: 34.7).

However, since there is no association between individual control and strain for employees in highly interdependent situations (see Table 5), there must be something about the strain-reducing potential of individual job

control that is specific to the setting. We believe that different types of demands occur within the two settings so that different types of actions are required to address them. It makes perfect sense that *individual* control is necessary to manage work demands for those who are in low interdependent jobs: by definition, work demands in low interdependence jobs are likely to affect only that individual. For example, consider the wire-drawer who has a problem with tangles in a coil of wire on the machine. The consequence of this problem is simply a loss of production on that one machine, with little impact on operators of other machines. What is important is whether the employee has the individual autonomy to sort out the problem, and there is little incremental benefit here in collective autonomy. Thus, within a situation where there is little natural interdependence, one would expect that many of the demands and problems that occur could be addressed by the individual job holder. Giving the job incumbent greater individual autonomy allows them to cope with the specific demands of that setting; but the low interdependence of the wire-mills inhibits the value of collective autonomy.

However, within a more interdependent situation, the problems that arise are likely to have a more widespread impact and require more than one person to manage them effectively. In such situations, individual autonomy will be insufficient because employees need to have influence over other team-members' actions. Autonomy allocated to the team will also be insufficient unless it is truly collective, distributed throughout the team – each team-member must have both the autonomy to act and the ability to influence others to act.

Our findings support the general proposition of sociotechnical systems theory that work designs should reflect the characteristics of the production process. In previous studies (Jackson & Wall, 1991; Wall et al., 1990), we have demonstrated this point for production uncertainty: operator control over task processes is appropriate in highly uncertain production environments and production variances should be controlled at source (the so-called sociotechnical criterion, Cherns, 1976). This study extends the same logic to include interdependence as a second production process characteristic. Readers of prescriptive texts on work design will not be surprised at our findings, since they accord with the advice of experts over many years. There are two elements of surprise here: first that few studies have tested out this proposition explicitly; and second that the organization we looked at went ahead at all with the reorganization on the advice of a leading consultancy.

The proportions of variance accounted for in the dependent variables by the predictors employed here are relatively low. While this clearly indicates that individuals' strain and satisfaction responses cannot be explained in any way totally by these variables alone, we would not expect them to.

Other factors, such as cognitive work demands, role characteristics and aspects of the organizational context, would clearly contribute to predictability. However, this is not the purpose of the study. Rather our primary aim is accounting for the observed difference in employee outcomes between roperies and wire-mills; and here the important thing is the partition of total effects into direct and indirect effects, and their relative size. In this respect, we have shown conclusively that the lower satisfaction and higher strain reported by employees in the wire-mills can almost all be accounted for by the difference in interdependence.

How generalizable are our findings, particularly in relation to the observed relationship between individual autonomy and strain for low interdependence settings? To some extent, the answer to this question depends on the levels of autonomy that we found within the two job groups. The mean individual task control scores shown for wire-drawers and rope-makers in Table 2 are indeed low by comparison with the norms reported by Wall et al. (1995). This is most marked for wire-drawers, who have little discretion over many aspects of their working life. It may be that the relationship between autonomy and strain is not linear: perhaps autonomy has little incremental benefit once a threshold is reached. Further research is needed to address this possibility; and once again we would make the point with which Wall et al. (1995) concluded their paper, that careful calibration of samples using common measures is necessary for research effort to be truly cumulative.

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