9-1-1997

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Abstract
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Keywords
economic, cost, benefit, teams, technicians, labor, performance, quality, productivity, wage, skill

Disciplines
Labor and Employment Law

Comments
Suggested Citation
Batt. R. (1997). *The economic costs and benefits of self-managed teams among skilled technicians* (CAHRS Working Paper #97-19). Ithaca, NY: Cornell University, School of Industrial and Labor Relations, Center for Advanced Human Resource Studies.
http://digitalcommons.ilr.cornell.edu/cahrswp/160

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WORKING PAPER SERIES

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Working Paper 97-19

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Draft. Not for quotation. Comments welcome.

THE ECONOMIC COSTS AND BENEFITS OF SELF-MANAGED TEAMS AMONG SKILLED TECHNICIANS

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Working Paper #97-19

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ABSTRACT

This paper estimates the economic costs and benefits of implementing teams among highly-skilled technicians in a large regional telecommunications company. It matches individual survey and objective performance data for 230 employees in matched pairs of traditionally-supervised and self-managed groups. Multivariate regressions with appropriate controls show that teams do the work of supervisors in 60-70% less time, reducing indirect labor costs by 75 percent per team. Objective measures of quality and labor productivity are unaffected. Team members receive additional overtime pay that represents a 4-5 percent annual wage premium, which may be viewed alternatively as a share in the productivity gains associated with innovation or as a premium for learning skills.

ECONOMIC COSTS AND BENEFITS OF SELF-MANAGED TEAMS AMONG SKILLED TECHNICIANS[1]

The theoretical and empirical research on teams has made substantial headway in understanding the relationship between characteristics and dimensions of work groups, on the one hand, and related outcomes such as attitudes, behaviors, and performance, on the other. While some research streams have focused more on psycho-social dimensions; others have investigated group dynamics and decision-making; and others, group structures, tasks, and processes (see reviews by Beekun, 1989; Bettenhausen, 1991; Cohen and Bailey, 1997; Guzzo and Dickson, 1996; Sundstrom, de Meuse, and Futrell, 1990). Over the last decade or so, in response to methodological criticisms (e.g., Roberts & Glick, 1981; Salancik & Pfeffer, 1978; Wagner & Gooding, 1987) as well as managerial preoccupation with firm competitiveness, researchers increasingly have studied objective performance outcomes, such as quality, service, and/or manager ratings of subordinates' performance.

Few studies, by contrast, have considered how team innovations affect labor productivity and labor costs, a current managerial concern and a classic concern in the fields of human resource management, labor economics, and industrial relations. Where researchers of teams have considered these costs at all, they have measured absenteeism or turnover rates, an important but secondary concern in the context of intense short-term cost pressures that characterize many business environments.

Researchers are unable to incorporate costs when they conduct studies out of organizational context because the relative costs of teams are contingent on the nature of the work, technology, organizational structure, and management strategy. By failing to bring in organizational context, researchers fail to incorporate economic costs, and therefore miss a critical dimension for evaluating team-based work organization[1]. Many studies over the last decade, however, have increasingly taken place inside organizations, but still without evaluating costs and benefits, or distributional outcomes. According to Cohen and Bailey's 1997 review, covering fifty-four studies of teams in organizational context published between 1990 and 1996, most studies analyzed outcomes along multiple dimensions (attitudes, behaviors, subjective perceptions of performance and/or objective measures of quality, quantity, or customer service);

[1] Support for this research came from the Alfred P. Sloan Foundation, the MIT Industrial Performance Center, the National Telecommunications Consortium, and the Center for Advanced Human Resource Studies, Cornell University. The author thanks Eileen Appelbaum, Lee Dyer, Barry Gerhart, Harry Katz, Jeffrey Keefe, George Milkovich, Paul Osterman, Jim Rebitzer, and Pat Wright for helpful comments. Copies of data analyses and computer programs used to generate the results presented in this paper are available from the author.

but only one (Pearson, 1992) analyzed labor productivity and economic costs. The omission of these measures raises important questions such as, do work groups with higher performance also work longer hours, receive higher wages, clock in more overtime, or absorb the costs through unpaid work time? In other words, are they working smarter or longer, or both? And what is the distribution of costs and benefits between firms and employees?

This lack of focus on costs in the teams literature is in contrast to management preoccupation in the last decade with intensified cost competition. In many companies, managers became focused almost exclusively on cost reduction strategies, with labor costs a central target. Some chose to dismantle experiments with work innovations such as teams or participation that require upfront and on-going costs of training, "unproductive" time in meetings, and sometimes long term dedication to changing ingrained employee behavior (e.g., Keefe & Batt, 1997). They abandoned them even though they believed, and substantial evidence exists, that these innovations have long term benefits. In the environment of the 1990s that witnessed a withdrawal of implicit employment security, many managers did not know if they would be around to reap the long term benefits. Others, however, discovered teams as a cost-saving strategy, and initiated self-managed team systems *primarily* to reduce labor costs and streamline organizations, *regardless of whether they also improved attitudes, behavior, or performance*[2].

The *idea* that team interventions and other work innovations have economic costs as well as benefits is not new (Carnall, 1982; Hackman, 1987; Polley & Van Dyne, 1994; Sussman, 1976), but a few empirical studies have assessed them. In their meta-analysis of 131 North American field studies between 1961 and 1991, for example, Macy and Izumi note that, "…the evidence regarding the economics of change efforts in organizations is scarce and unreliable… With regard to the costs and benefits of change programs such as job enrichment, sensitivity training, participative management, autonomous work teams, and the like, the situation is even worse" (1993: 238). Only 16 studies, or 12% of the total, included any measures of economic cost[3].

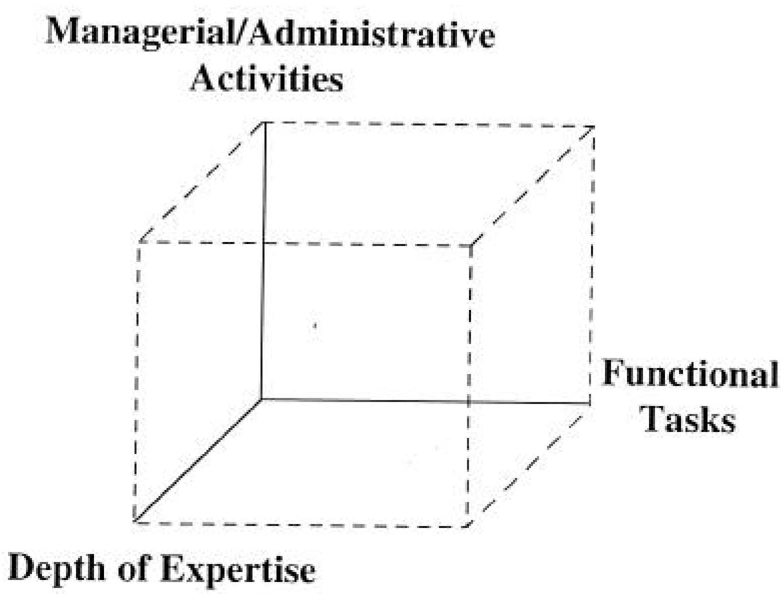
This paper contributes to the literature on teams by providing a framework for analyzing the determinants of economic costs and benefits associated with team interventions. It demonstrates the advantage of using an understanding of organizational context to shape hypotheses, identify appropriate outcome measures, and interpret empirical results. It tests a model of team organization appropriate to highly-skilled technicians; it then estimates the performance outcomes of teams along multiple dimensions: self-reported work behavior, occupation-specific objective data on quality and customer service, hours of work, hourly productivity, and relative distribution of economic costs and benefits.

THEORY AND HYPOTHESES

In this paper, I use the term work group to mean a collection of individuals who have significant interdependent relations, who perceive themselves and are perceived by others as a group, and who have significant interdependent relations with other groups in a larger social system (Alderfer, 1977: 202; Guzzo & Dickson, 1996; Hackman, 1987). I use self-managed teams, or teams, interchangeably to mean work groups who are semi-autonomous or largely selfmanaging. They assume all of the responsibilities of a traditional supervisor; they call on a "coach" only on an as-needed basis for advice or consultation. They are not "autonomous" or "self-designing" (Hackman, 1987) in that they are embedded in a large organization with hierarchical management structures largely intact. The subjects of the study are field technicians, highly skilled and independent craftsmen, who install and maintain network transmission and switching equipment. They traditionally are organized into work groups, headed by a supervisor, and based in geographically-dispersed field offices from which they are deployed individually to handle customer demands.

To conceptualize the differences between self-managed and traditionally-supervised groups, I draw on Klein's (1994) model of small business teams (SBTs), which builds on, but goes beyond, sociotechnical systems theory (e.g., Cummings, 1978; Pearce & Ravlin, 1987; Trist & Bamforth, 1951). It provides a parsimonious framework for conceptualizing the tasks and skills associated with team membership along three dimensions: vertical (managerial/administrative), *horizontal* (functional, cross-functional), and *analytical* (technical or craft expertise) (see Figure 1). Managerial tasks are those of coordinating the group's activities and running the operation, frequently referred to as internal coordination in the STS or groups literatures. Functional tasks are those required to produce the output; these may include a range of functional tasks (job enlargement) as well as cross-functional coordination. Analytical dimensions refer to team members' responsibility for analyzing and solving problems related to completing work-related tasks, comparable to the concept of craft autonomy and skill in the STS literature. The model is a useful diagnostic tool for comparing job design under different systems. For example, mass production jobs are limited on all three dimensions; traditional craft jobs have great analytical depth, and some breadth, but few vertical responsibilities. Lean production teams have considerable breadth through job enlargement or rotations, and more analytical depth than typical mass production jobs, but little self-management. Self-managed teams, by contrast, should have high levels of vertical, horizontal, and analytical skills, in essence "filling the entire box" in Figure 1.

FIGURE 1



Klein's framework is particularly appropriate for this study because it focuses on the differences between self-managed and traditionally-supervised groups, in contrast to the literature on groups, which focus more heavily on group processes, dynamics, and effectiveness, regardless of the management structure in which they are embedded. In addition, while building on STS theory, Klein's framework departs from it by developing a model appropriate for skilled technical and professional employees. STS theory, by contrast, grows out of studies of blue collar mining and manufacturing workers in mass production operations. The central difference is in the hypothesized direction of change with respect to the design of jobs and skill requirements. STS theory predicts that team innovations allow workers to shift from narrow, "Taylorized" jobs to broader ones, increasing breadth through job enlargement or job rotation so that team members "complete a whole task" or understand a whole process (e.g., Pasmore et. al., 1982; Pearce & Ravlin, 1987). Klein argues that technicians already "complete a whole task;" their performance depends on maintaining high levels of specialized expertise, rather than becoming "a jack of all trades and master of none." Reorganization into teams is unlikely to produce dramatic changes in breadth of jobs, or job enlargement. Second, the STS literature assumes high levels of interdependence, as in mining or manufacturing, and adopts the group as the unit of analysis, as does the literature on group effectiveness (e.g., Alderfer, 1977; Goodman et. al., 1986; Hackman, 1987; McGrath, 1986). Klein's framework, by contrast, recognizes the importance of measuring individual level outcomes as well. That is, while team structures are likely to increase internal coordination and interdependence within groups, highly skilled technicians and professionals also are likely to work quite independently, depending on the specialized demands of the work, technology, and customers. Doctors, lawyers, or computer technicians are likely to benefit from team structures for purposes of internal and external coordination and better learning and consultation, but are still held accountable for their own individual hours of work, productivity, and performance for particular clients. Network technicians in this study tended to specialize in different types of work functions (e.g., as linemen, cable splicers, installers, repair men) and for different types of customers (residential, small business, large business). Although Klein does not explicitly discuss how her model relates to the role of traditional supervisors, it provides a useful guide. Their traditional *vertical* activities include group task allocation and coordination, scheduling, and reporting; their *horizontal* responsibilities include cross-functional coordination between the group they supervise and other constituencies (other work groups, departments, suppliers, customers); and their *analytical* role involves providing training and development to individual employees and addressing non-routine problems that employees are unable to resolve. This discussion leads to the first hypothesis.

> Hypothesis 1a: Members of self-managed teams have significantly higher levels of skills and responsibilities than those in traditionally-supervised groups along three dimensions: group self-management; external coordination across groups, departments, and customers; and analytical expertise in the execution of individual jobs. They do not vary with respect to task or functional specialization.

The null hypothesis is equally plausible. Based on STS theory, one might argue that highly skilled technical and professional employees are by definition "self-managing." To accomplish their work, they must coordinate within their group, handle relations with suppliers and customers, and utilize craft or analytical skills to accomplish complete projects. They have little to gain from team strategies. In this study, evidence from field interviews supported this view. Some technicians in the team program viewed it as "merely formalizing" what they already did informally. An alternative hypothesis focuses on the voluntary nature of participation in work innovations such as teams. In this case, the voluntary nature of the program introduces selection bias as an alternative hypothesis. Volunteers who self-select into teams may differ systematically from those who do not. For example, they are likely to already exhibit characteristics associated with teams, suggesting that it is not the program that produces differences between self-managed and traditionally-supervised technicians, but the individual attributes of employees who volunteer for the program. In this study, technicians volunteered for the program, and if they could reach consensus among members of their work group, they would "become self-managed." The supervisors, in turn, became "coaches," were not physically located in the same work site as the technicians, and were called upon only on an as-needed basis. Selection-bias suggests that:

> Hypothesis 1b: Volunteers for the self-managed team program differ significantly from non-volunteers along dimensions of interest: in their absorption of managerial and cross-functional tasks and in their greater autonomy and skill in the performance of their individual jobs.

Another way of thinking about selection bias is to consider differences in the chronology of volunteering. Those who initially volunteer to participate in work innovations are likely to be more entrepreneurial or less risk-averse than later volunteers who wait to assess the initial outcomes of experiments. Early volunteers are likely to be already doing "informally" what the team program requires. Therefore, we might expect early volunteers to assume more responsibilities and have better performance outcomes than later volunteers.

> Hypothesis 1c: Early volunteers for teams will exhibit higher levels of vertical, horizontal, and analytical responsibilities than will later volunteers to the program. The second research question concerns the performance outcomes of self-managed teams.

If the hypothesized relationship does exist between new tasks and skills and team membership, then what are the hypothesized effects on quality and productivity? Both STS theory and Klein's model predict improvements in quality and productivity resulting from self-managed teams because team members "jointly optimize" the social and technical systems (e.g., Pearce & Ravlin, 1987; Trist & Bamforth, 1951). Tacit knowledge of the production process coupled with greater autonomy and group synergies are likely to lead to process innovations, improving quality and efficiency.

Reviews of empirical studies of the relationship between self-managed teams and performance consistently find significant positive (Beekun, 1989; Guzzo et. al., 1985; Pearce and Ravlin, 1987); and some note that teams produce stronger results than other forms of participation (e.g., Cohen & Bailey, 1997; Cotton, 1993). Yet, as indicated above, most studies focus on blue-collar workers; outcomes for skilled workers may be quite distinct. In addition, the positive results in meta-studies primarily draw on research in which performance is defined in widely different ways: output volume, error rates, one-time cost savings, absenteeism, turnover, withdrawal, self-reports and/or managerial observations.

For example, empirical studies have found positive results using managerial evaluations (Campion, Medsker, and Higgs, 1993; Cohen and Ledford, 1994; Cohen, Ledford, and Spreitzer, 1996; Yammarino and Dubinsky, 1990) and occupation-specific objective measures of quantity, quality, effectiveness, error rates (e.g., Campion, Medsker, and Higgs, 1993; Edmondson, 1996; Pearson, 1992; Preuss, 1996; Seers et. al., 1995; Vinokur-Kaplan, 1995; Wageman, 1995). Ancona's research shows significant positive effects of cross-functional coordination or "boundary spanning" behavior (e.g., Ancona, 1990; Ancona & Caldwell, 1992). While these papers provide very useful objective measures of performance, they are incomplete because they omit labor inputs. Only Pearson includes a classic measure of productivity -- output per labor hour of input. While it is plausible that little variation in hours exists, it is equally plausible that groups with better performance along some dimensions have actually lower productivity. Higher performing groups may take longer; or put in extra time, skipping lunches or breaks, arriving early, staying late. "Unproductive meeting time" has been a major complaint among both management and employees who have experimented with participatory and team based systems, and this may be an important source of lower productivity. This discussion indicates the importance of separating the hypothesized effects of teams on various dimensions of performance and productivity.

Considering first the hypothesized effects of teams on quality and customer service, the theoretical and empirical literature would argue for positive effects of teams:

> Hypothesis 2: Members of teams will outperform members of traditionally-supervised groups along occupation-specific measures of quality and customer service.

The null hypothesis regarding better quality and service outcomes in this case is plausible for a number of theoretical reasons. The team innovation faced a highly-constrained technological, organizational, and institutional environment. First, the "systemness" of the network technology (or the need for standardization across the network) provides few opportunities for decentralized small groups to undertake process innovations on their own. Second, management strategy was inconsistent with positive team outcomes along quality and customer service dimensions because there was no coherent strategy to compete on quality (e.g., Arthur, 1991; Becker & Gerhart, 1996). Instead, teams were instituted as an explicit cost-cutting strategy[4] in response to industry deregulation[5]. Management retained control over key decisions that influence performance, such as customer service strategy, performance requirements, and choice of technology, and failed to provide the kind of organizational support and training resources viewed by theorists as necessary for success (e.g., Hackman, 1987; 1990; Lawler et. al., 1986). Teams were not instituted as part of an integrated cluster of innovations, as advocated in theories of industrial performance (e.g., Berg, Appelbaum, Kalleberg, and Bailey, 1996; Ichniowski et. al., 1996; MacDuffie, 1995).

Finally, teams faced a highly institutionalized environment. Institutional theory argues that work norms and customs pose significant constraints to change (e.g., Scott, 1995). Institutional constraints in this case included regulatory requirements guiding safety and customer service as well as the one-hundred-year old Bell System of internal labor markets, institutionalized through union contracts. These created a very stable, experienced, and homogenous workforce with high levels of company-provided training and implicit lifetime employment security. The typical employee in this sample is white, male, 45 years old, has the equivalent of one year of post secondary college or technical training, and has 22 years of tenure with the company. These characteristics suggest that work norms regarding quality and productivity ("a fair day's work for a fair day's pay") are deeply ingrained and difficult to change through the introduction of work innovations. In addition, the union contract reduces variation in many human resource policies (job bidding and promotions, compensation, benefits, etc.); and the company and the union jointly sponsored the self-managed team program and negotiated parameters which set limits on local variation. The contract prohibited any wage premium or gainsharing attached to team participation, thereby reducing incentives for better performance. Top management required local managers to work with local union leaders to develop written agreements specifying what occupation-specific tasks and responsibilities would be taken over by the teams, usually with a two-three month transition period. These institutionalized constraints argue for very modest, if any, positive effects of the team program.

With respect to productivity and labor costs, the hypothesized outcomes of shifting from traditionally-supervised to self-managed teams depend upon the net effect of two factors: a) process innovations introduced by teams which may improve productivity; and b) absorption of indirect labor tasks which may decrease overall productivity, defined as output per labor unit input. The extent of the negative effect on productivity depends centrally on what types of supervisory tasks or functions teams absorb; what they absorb, in turn, depends on both the nature of the production process (what tasks are required of supervisors) and managerial strategy (which of those tasks does management choose to delegate to teams). For example, in a study of self-managed customer service teams, where management information systems determine schedules, electronically monitor performance, and track sales, team absorption of supervisory tasks is relatively costless (Batt, 1996). If the work process, by contrast, requires heavy internal or external coordination, then the cost savings associated with teams will be substantially less. For example, in construction projects requiring high levels of coordination between suppliers, engineers, subcontractors, workers, and clients, retaining supervisory coordination may be more cost-efficient than a team-based approach. In a study of cross-functional coordination in the airline industry, for example, Hoffer-Gittell (1996) actually finds that higher levels of supervision are associated with higher performance. Returning to Klein's model, all three dimensions (vertical, horizontal, analytical) of the supervisory work associated with network technicians appear to be significant and time consuming, closer to the construction model than to the office model discussed above. First, group management responsibilities include assigning tasks; scheduling work hours, breaks, overtime; and satisfying reporting requirements for regulatory standards covering customer service quality and safety. Second, external coordination responsibilities include coordination with other line managers and subject matter experts in a variety of departments: construction where trunklines are damaged, engineering vis-a-vis pre-survey work, other network managers vis-a-vis negotiations over turf responsibilities; customers concerning complaints, and Cable TV and power companies (since they often share joint-use poles). Third, supervisors spend considerable time in the field, evaluating the performance of technicians, providing coaching or training, and conducting quality and safety inspections.

> Hypothesis 3a: Members of teams will have lower overall productivity than those in supervised groups. The time that it takes team members to perform indirect labor (supervisory tasks) should reduce time available for direct labor, leading to reductions in labor productivity, defined as output per direct labor unit input.

Alternatively, if team members work longer hours to absorb new indirect labor tasks, then labor productivity is unlikely to be negatively affected. Labor costs may also be unaffected if team members are exempt employees: they may simply work longer hours without receiving additional compensation. For non-exempt employees, however, overtime hours will be compensated, and the relative costs of the team program will increase for employers; team members will share in some of the economic gains through higher compensation. Weisman, Gordon, & Cassard (1993), for example, found that nurses in self-managed units work longer hours and have higher pay. Given that this study involves non-exempt employees in a unionized setting, it is likely that they adhere closely to rules governing overtime pay.

> Hypothesis 3b: The labor productivity of self-managed and traditional work groups is not significantly different. Team members work extra overtime hours to absorb supervisory tasks, leading to a sharing in the distribution of costs and benefits associated with teams.

Estimating the distribution of costs and benefits consists of a fairly straight-forward accounting of hours of direct labor, time in meetings and training, and overtime hours associated with self-managed versus traditionally supervised work groups. Even if team members have lower productivity than those in traditional groups, net cost savings for employers may accrue if compensation costs associated with supervisors are higher than those of teams. To consider the distribution of costs and benefits, therefore, I compare the amount of time it takes teams versus supervisors of traditional groups to accomplish administrative, reporting, coordination, and other supervisory tasks, and estimate associated labor costs and wage outcomes.

RESEARCH STRATEGY AND METHODS

The research strategy for this study combines qualitative field research across several companies in one industry with a detailed quantitative study in one representative company. Field research contributed to understanding the tasks and skills requirements of technicians' work, the differences in roles and responsibilities for employees working in traditional versus self-managed work groups, and occupation-specific performance measures. The choice of a quantitative study in one company helps to control for wide variation in organization-level variables such as corporate "culture," business strategy, and human resource and industrial relations policies, in order to focus more carefully on the variables of interest that determine team performance.

To operationalize the effects of organizational context on teams, this study draws on the strategic human resources and industrial relations literature, which pays special attention to the nature of work, technology, markets, and human resource and industrial relations variables (see for example, Cappelli and Singh, 1992; Dyer and Holder, 1988; Kochan and Osterman, 1994; Osterman, 1994). This research is characterized by industry specific studies that empirically test the effects of technology, work organization, and human resource practices on performance. The performance model in this study, for example, incorporates measures of technology; state-level variation in management systems; variation across rural, urban, and suburban districts; and variation in the nature of work assignments across residential and business customers.

Sample

The data for the study consist of a stratified random sample of network technicians in a several state area. A pre-post test design was not possible because team formation preceded the date of availability of objective performance data. That is, because the program was voluntary and on-going in nature, the initial start-date of teams varied from 1988 to the beginning of 1993. Objective data on performance was not available until the beginning of 1993. Therefore, equal numbers of self-managed work groups and randomly-selected traditionally-supervised work groups were matched by management division (state) and service market location (state; urban, suburban, rural; residential, small business, large business). A random subset of employees in each work group received mail surveys in January, 1994; and 58% responded for a total of 373 technician surveys. The performance model is based on matching the sample of respondents from the survey with individual level productivity data from the company's computer-based Activities Measurement Plan (AMPs). The performance data include individual monthly data for the period January, 1993 to May, 1994. Of the 373 surveys from employees, matching performance data was available in 230 cases. Not all individuals could be matched because some states were not fully participating in the company-wide information system[6]. The usable data for the objective performance model include 128 employees from 49 traditional work groups and 102 individuals from 45 self-managed teams.

Measures

Definitions of all variables are provided in Appendix A. Independent and control variables are based on survey responses covering several domains of interest: work organization, human resource and industrial relations practices, demographic characteristics, and service market characteristics. To operationalize Klein's model, the vertical dimension is a five-item scale measuring group responsibility for goal-setting, task allocation, and scheduling ($\propto$ = .74). The horizontal dimension has two indices: a) job enlargement, an additive index of the number of different types of jobs routinely performed by the technician; and b) cross-functional coordination, a two-item additive index measuring frequency of interaction with managers and subject matter experts outside of the employees' department. Analytical expertise is conceptualized along three dimensions: a) formal training (number of days of company-provided formal training in the previous two years); b) informal teaching (a frequency scale measuring how often work group members help each other with non-routine problems); and c) craft autonomy (control over pace, tools, procedures, and authority to meet customer needs, $\propto$ = .74).

To identify team members and volunteers, I used a series of dummy variables. SMT membership is a dummy variable, where 1 represents membership in a team and zero equals membership in a traditionally-supervised work group (TWG). To identify current volunteers, I included a survey question asking whether *employees* in *traditional work* groups would volunteer for teams if given the opportunity. That is, while it is not possible to analyze volunteers who are already in teams, it is possible to analyze the characteristics of current volunteers. SMT volunteer is a dummy variable where 1 represents a technician in a traditional work group who would volunteer to join a self-managed team, and 0 equals all other traditional group members. To compare early volunteers to later volunteers, I divided the employees *currently in self-managed teams* into two groups: those that began between 1988 and 1991 (early teams), and those that began in 1992-1993 (new teams). "New team" is a dummy variable where 1 equals members of teams formed in the later period, and 0 equals those formed in the earlier period.

Measures of other work and human resource practices include: a) technology (the technician's estimate of the percentage of plant and equipment he works with that is "interfaced," that is, modernized[7]; b) TQM member (a dummy variable where 1 equals current participation in total quality problem-solving teams, else 0); c) supervisory or coaching support (a six-item scale covering supervisory feedback, respect for employees, fairness, provision of resources, time, and support for quality, $\propto$ = .85); d) perceived promotional opportunities (a one-item question); and e) annual earnings. It is worth mentioning that the supervisory scale is intended to measure what would be considered positive behaviors for all supervisors, *regardless* of whether he or she assumes traditional responsibilities or a more hands-off role as a "coach" or facilitator of a team. It is *not intended to measure differences in the responsibilities* of traditional supervisors versus coaches of teams. Employment relations variables measure union membership, and the degree of perceived conflict or cooperation in work group relations and in labor-management relations. Demographic characteristics cover age, gender, race, company tenure, and education. A series of state-level dummies control for variation in management practices across states; the omitted state is the one where corporate headquarters is located. Dummies for rural, urban, and suburban location define employees according to their primary work location. Similarly, dummies for residential, small business, and large business customers capture which customers the technicians primarily serve.

The dependent variables in the performance model include three measures of quality. The first, self-reported quality, is a two-item scale measuring quality and quality improvement ($\propto$=.57). Company measures of quality are missed appointments per month (the number of times a technician misses an appointment when given adequate time to meet it) and multiple dispatches per month (the number of times that a technician requires additional assistance on a job). Hours of work include several categories: direct productive labor (hours spent doing service installation and repair); "unproductive" labor which includes unclassified hours (paid time spent in meetings and training), and undistributed hours (paid time for vacation, sick leave); overtime (hours worked over 40 hours per week); and total hours (all categories combined). Productive hours include driving time, which is considerable in this sample (averaging 1.8 hours per day) due to the high percentage of technicians serving residential and rural populations. Productivity is measured as productive hours per completed dispatch (to a customer's premises) and total hours per completed dispatch.

The organizational context in this study raises serious measurement problems. First, there is much greater variation in environmental factors among field technicians than among employees in manufacturing plants or office settings where the physical and technological environment is more standardized. Controlling for environmental variation in this study is highly problematic: technicians in inner cities face higher crime rates; those in rural areas have significantly longer driving distances between customers, but productivity measures do not net out driving time. Weather conditions, a key environmental factor that shapes quality and productivity, not only vary by location and over time but are highly unpredictable. Coastal areas with hurricane seasons have much higher rates of trouble and repairs than inland areas. Regions with higher percentages of aerial cable are much more vulnerable to weather conditions than those with buried cable. The extent of modernization of plant and equipment varies by neighborhood and significantly affects the quality of customer service as well as the time it takes technicians to complete a job.

In addition, the quality indicators used by the company are highly influenced by the state of the technology. While fiber optic cable requires little or no maintenance, for example, lead core and copper wires do, and are much more vulnerable to deterioration due to bad weather. Missed appointments and multiple dispatches may increase in regions with high demand due to inclement weather, or where districts are understaffed. Finally, unlike a manufacturing plant or office where an employees work on a limited set of equipment, in any given day a technician may work on lead core cable that is 60 years old and fiber cable that is brand new. Many environmental factors, therefore, are beyond the control of technicians, but nevertheless affect their objective performance records. Local managers who are familiar with the state of the local plant, equipment, and seasonal effects on that equipment, are more able to take these factors into account when they interpret the performance records of individual technicians. I will discuss the implications of these measurement issues more fully in the discussion of the results.

A second issue concerns the appropriate unit of analysis. Most models of group effectiveness argue for a group-level unit of analysis (e.g., Alderfer 1977; Goodman et. al., 1986; Hackman, 1987; McGrath, 1986). As indicated above, the work of field technicians differs markedly from a manufacturing setting where team members all contribute to the output of a given product. Technicians' work is highly individualized. The self-managed teams are responsible for coordinating the work in their service area, but members are still held responsible for individual jobs. In addition, because of the great variation in environmental conditions facing technicians, it is particularly important to include a large number of control variables. Aggregating to the group level reduces sample size, and hence, there is a trade-off between level of analysis and model specification. For these reasons, I analyze the data at the individual unit of analysis. However, because individuals were randomly sampled within groups, rather than independently, I use a Huber correction technique in probit and OLS regressions to test whether there is a "work group" or cluster effect. Where cluster sampling exists, this technique creates more robust standard errors (Huber, 1967).

ANALYSIS AND RESULTS

Table 1 summarizes the means and standard deviations of variables for all employees, and for those in self-managed versus traditional work groups. Appendix B provides a correlation matrix of all variables. Significant differences in means exist between members of traditional and self-managed groups along several variables of interest. With respect to outcome measures, members of teams have significantly higher levels of self-reported work quality, but fewer productive work hours per month and more unproductive hours. With respect to the variables that measure the Klein model of work organization, team members have significantly higher mean averages than members of traditional groups in all measures of vertical, horizontal, and analytical dimensions. Notably they also report significantly less supervisory or coaching support and more cooperative work group relations. For other control variables, there are no significant differences in the demographic profiles of employees from the two groups, which is consistent with the homogenous nature of the workforce. There are some significant differences in the distribution of self-managed and traditional groups by service market characteristics so that inclusion of these variables as controls in the full model is particularly important.

TABLE 1
Means of Variables for
All Technicians, Traditionally Supervised, and Self-Managed

Variable	All Mean	Std. Dev.	TWGs Mean	SMTs Mean
Dependent Variables				
Work group quality	4.10	0.64	3.98	4.25 ***
Missed appointments/mo.	1.32	1.13	1.34	1.29
Multiple dispatches/mo.	7.64	3.53	7.59	7.70
Productive hours/mo.	157.34	5.29	158.28	156.15 ***
Overtime hours/mo.	31.02	18.77	30.04	32.25
Total hours/mo.	203.80	19.36	203.17	204.58
Unproductive hours/mo.	15.44	5.23	14.85	16.18 *
Total dispatches/mo.	71.33	17.13	71.83	70.71
Productive hrs/dispatch/mo.	2.36	0.74	2.37	2.35
Total hrs/dispatch/mo.	3.05	0.95	3.03	3.07
Team Membership				
SMT member	0.44	0.50		
SMT volunteer			0.33	
New team member				0.42
TQM member	0.20	0.40	0.18	0.22
Work & HR Practices				
Group self-management	2.29	0.74	1.97	2.70 ***
Job enlargement	6.42	2.31	6.15	6.76 +
Cross-functional coordination	2.48	1.17	2.12	2.94 ***
Formal training	5.90	8.62	4.99	7.03 +
Informal teaching	3.21	1.27	2.76	3.76 ***
Craft skills	2.85	0.89	2.64	3.13 ***
Technology (% new plant)	80.08	16.15	81.41	78.47
Supervisor/coaching support	3.26	0.95	3.37	3.12 +
Promotion opportunities	2.54	1.19	2.51	2.58
Annual earnings	46585.90	8603.63	46507.93	46683.16

TABLE 1 (continued)
Means of Variables for
All Technicians, Traditionally Supervised, and Self-Managed

Variable	All Mean	Std. Dev.	TWGs Mean	SMTs Mean
Employment Relations				
Work group relations	4.26	0.78	4.10	4.46 ***
Labor-management relations	3.19	1.02	3.14	3.25
Union membership	0.89	0.31	0.88	0.91
Demographic Characteristics				
Age (yrs.)	44.86	5.47	44.79	44.96
Gender	0.04	0.20	0.06	0.02
Race	0.92	0.28	0.910	0.92
Tenure	22.00	5.20	21.82	22.22
Education (yrs.)	12.91	1.13	13.00	12.79
Service Market Characteristics				
State Location				
State 1	0.04	0.20	0.05	0.03
State 2	0.05	0.21	0.05	0.05
State 3	0.30	0.46	0.31	0.27
State 4	0.04	0.19	0.06	0.01 *
State 5	0.14	0.35	0.10	0.19 +
State 6	0.17	0.38	0.09	0.26 ***
State 7	0.14	0.35	0.16	0.13
State 8	0.12	0.33	0.17	0.06 **
Geographic Location				
Rural	0.43	0.50	0.35	0.52 **
Urban	0.26	0.44	0.27	0.25
Suburban	0.23	0.42	0.82	0.94 *
Customer Base				
Residential	0.87	0.33	0.82	0.94
Small business	0.06	0.24	0.05	0.08
Large business	0.02	0.15	0.08	0.08

*TWGs and SNITs are significantly different at: *** = p<.001; ** = p<.01; * = .05; + = p< .10.

Hypothesis One

To analyze whether Klein's model is useful for conceptualizing differences between self-managed and traditionally-supervised groups, I developed a probit model which estimates the characteristics that predict team membership, while controlling for important environmental variables (other HR practices, demographics, and service market characteristics). I use the same model to estimate the factors which predict team volunteers and early versus later volunteers. I use a probit model because the team and volunteer variables are dichotomous. The probit model is not a causal model, but estimates the probability that hypothesized independent variables predict dependent variables[8].

The results, reported in Table 2, show considerable support for Klein's model of teams among high-skilled technicians. Group self-management, cross-functional coordination, informal teaching and craft skills all predict team membership. Notably, job enlargement and formal training do not. In other words, maintaining functionally-specialized work tasks is consistent with being a member of a team, a finding that is also consistent with reports from field interviews.

In addition, employees who receive less support from their supervisors are more likely to be in teams. The interpretation of this finding deserves some discussion. The scale measures the extent to which supervisors provide feedback, treat employees fairly, and provide adequate supportive resources. For those in teams compared to those not in teams, the supervisor is, by definition, absent -- that is, not present to provide feedback or support. This finding is also consistent with the context of this study, where teams were set up in order to reduce costs. They did not receive the kind of resources or support from "coaches" that theorists view as necessary for success.

TABLE 2
Predictors of Team Members and Team Volunteers

	Team Members	Team Volunteers	New Team Members
Work Organization			
Vertical Tasks			
Self-management	0.76 ***	-0.63 +	0.09
	0.22	0.35	0.26
Horizontal Tasks			
Job enlargement	-0.07	0.06	-0.01
	0.05	0.07	0.08
Cross functional coordination	0.21 *	0.24	0.13
	0.11	0.17	0.15
Analytical Skills			
Formal training	0.00	-0.03	0.00
	0.01	0.02	0.02
Informal teaching	0.43 ***	-0.22 +	-0.30 *
	0.11	-0.30	0.15
Craft autonomy	0.44 **	0.56 **	0.29
	0.15	0.22	0.17
Supervisor/coach support	-0.60 ***	-0.43 *	0.10
	0.16	0.22	0.22
Demographics			
Age	0.01	-0.10 *	0.01
	0.03	0.05	0.04
Gender	-0.45	0.20	-
	0.64	0.73	-
Race	-0.59 *	-0.54	1.02 *
	0.31	0.71	0.44
Tenure	0.05	0.03	-0.02
	0.03	0.04	0.05
Education	-0.20 *	0.17	0.08
	0.11	0.12	0.17

TABLE 2
Predictors of Team Members and Team Volunteers

	Team Members	Team Volunteers	New Team Members
Service Market			
State 1	-0.85	-0.05	1.80
	0.80	0.48	1.08
State 2	0.98	-1.00	2.07
	0.69	0.77	1.10
State 3	-2.07 **	-1.15	-
	0.70	0.77	-
State 4	-0.29	-0.24	2.08 **
	0.51	0.46	0.80
State 5	0.16	0.20	1.24 *
	0.56	0.60	0.72
State 6	0.08	0.57	1.58
	0.58	0.61	0.70
State 7	-0.35	-1.25 *	1.84 *
	0.60	0.55	0.94
Geographic Location			
Rural	0.54 +	-0.78 +	0.29
	0.33	0.45	0.35
Urban	0.59 +	0.02	0.12
	0.33	0.39	0.35
Customer Base			
Residential	1.46 **	0.16	0.98
	0.51	0.39	1.03
Constant	-2.48	2.95	-5.25
	2.23	2.54	3.43
Sample size	193	102	92
Adjusted R^2	0.46	0.26	0.23

* = p<.001; ** = p<.01; *** = p<.05; + = p<.10

Comparing these findings with the model for volunteers provides additional insights. Notably, volunteers are similar to team members in that both experience significantly greater craft autonomy and significantly less support from their supervisors than their counterparts. The difference is that in the case of team members, the supervisor is already absent; in the case of volunteers, the supervisor officially should be present but volunteers perceive that they are not getting the support they need. If they are not getting that support, they might as well formally assume the supervisor's responsibilities. In addition, and in contrast to team members, those technicians with significantly less responsibility for group-management and who experience less teaching among group members are more likely to be volunteers. This suggests a profile in which technicians self-select into the team program if they already exercise considerable autonomy in their own individual work, but do not get what they need from their current supervisors; they are interested in forming teams so that they can gain the benefits of self--management and increased learning that comes through increased interdependence. Unlike team members, they do not already experience higher levels of self-management, cross-functional coordination, or informal learning among one another. Overall, the Klein model explains significantly more variation for teams (R^2 = .46) than for volunteers (R^2 = .27).

These results suggest that technicians in the formal team program are significantly more likely to adopt supervisory responsibilities than are their counterparts in traditional groups[9]. That is, the team program is more than a "mere formalization" of what employees are already doing. Individuals in teams are more likely than their counterparts to manage schedules, assignments, and overtime coverage; to coordinate with outside experts in their day to day work, rather than turning over those interactions to a supervisor; and to consult with each other to solve non-routine problems.

The second alternative hypothesis concerns whether older volunteers differ significantly from newer volunteers. The results, also presented in Table 2, show no significant differences in vertical or horizontal tasks and responsibilities. New team members are somewhat less likely to help each other informally ($p < .05$) and slightly more likely to have craft expertise ($p <.10$). The explanatory power of the overall model is lower than the first volunteer model (R^2 = .23). This finding has additional implications. Some researchers have found that the effects of innovations rise and then fall over time (e.g., Griffin, 1988; Lawler & Mohrman, 1987). This study finds quite consistent characteristics of tasks and responsibilities across older and more recent teams.

Hypothesis Two

Turning to the performance effects of teams, the outcomes are quite mixed, and the differences between subjective and objective measures of quality are notable. I explored a series of models, including simple analysis of variance, OLS regressions controlling for human resource practices and demographic variation, and a full performance model that controls for relevant work, human resource, and industrial relations variables; demographic characteristics; and service market characteristics. Table 3 reports the results of the full performance model, which shows that team membership has a significant positive effect of self-reported quality but not objective measures of missed appointments or multiple dispatches. These findings are quite robust across model specifications.

TABLE 3
Determinants of Work Quality of Network Technicians:
Subjective and Objective Measures Compared

	Self-Reported Quality	Missed Appts.	Multiple Dispatches
Independent Variables			
Work/HR Practices			
SMT membership	0.31 **	0.07	0.53
	(0.10)	(0.13)	(0.52)
TQM membership	-0.03	-0.14	-0.60
	(0.12)	(0.14)	(0.52)
Technology	3.89E-05	-0.01 *	-0.01
	(0.00)	(0.00)	(0.01)
Job enlargement	0.010	-0.01	0.03
	(0.02)	(0.04)	(0.14)
Training	-0.010	-0.02 *	-0.04
	(0.01)	(0.01)	(0.03)
Supervisor/coach support	0.17 ***	-0.03	-0.13
	0.05	(0.07)	(0.36)
Promotion opportunities	0.040	0.05	-0.07
	(0.04)	(0.05)	(0.18)
Earnings	-1.61E-06	1.53E-05	4.66E-05
	(6.44E-06)	(9.74E-06)	(3.43E-05)
Employment Relations			
Work group relations	0.19 ***	-0.08	-0.34
	(0.05)	(0.07)	(0.33)
Labor-management relations	-0.08 +	0.05	0.49 +
	(0.05)	(0.08)	(0.27)
Union membership	0.37 *	-0.09	-0.19
	(0.18)	(0.18)	(0.63)
Demographics			
Age	-0.01	0.03 +	0.04
	(0.01)	(0.02)	(0.05)
Gender	0.10	0.72	3.89 *
	(0.28)	(0.69)	(1.59)
Race	-0.14	0.31	0.14
	(0.15)	(0.24)	(1.00)
Tenure	-0.00	-0.02	-0.07
	(0.01)	(0.02)	(0.06)
Education	0.01	0.04	0.10
	(0.05)	(0.05)	(0.24)

TABLE 3 (continued)
Determinants of Work Quality of Network Technicians:
Subjective and Objective Measures Compared

	Self-Reported Quality	Missed Appts.	Multiple Dispatches
Service Market			
State			
State 1	-0.55	-1.34	-3.15
	(0.23)	(0.28)	0.84
State 2	-0.29	1.08	2.66
	(0.27)	(0.51)	(1.15)
State 3	-0.11	-1.47	-1.76
	(0.21)	(0.51)	(1.87)
State 4	0.06	-1.79	-2.57
	(0.13)	(0.17)	(0.85)
State 5	-0.17	-1.69	-2.38
	(0.13)	(0.18)	(0.93)
State 6	0.25 +	-1.04	-3.74
	(0.15)	(0.18)	(0.86)
State 7	-0.13	-1.50	-3.14
	(0.17)	(0.20)	(0.86)
Geographic Location			
Rural	0.10	0.10	-0.54
	(0.12)	(0.14)	(0.53)
Urban	0.16	0.18	0.80
	(0.12)	(0.13)	(0.54)
Customer Base			
Residential	-0.06	0.23	1.16
	(0.20)	(0.19)	(1.24)
Small business	-0.50	0.48	1.97
	(0.61)	(0.91)	(5.12)
Constant	3.01	0.603	5.58
	(1.09)	(1.08)	(4.84)
Sample size	184	185	185
Adjusted R 2	0.18	0.51	0.20

Standard errors in parenthesis.

Significant differences: ***=p<.001; **=p<.01; *=p<.05; +=p<.10

Hypothesis Three

Hypothesis three considers whether team membership leads to lower productivity, on the one hand, or longer working hours, on the other. The cross tabulation of means reported in Table 1 suggests that there are no significant differences between technicians in traditionally-supervised and self-managed groups in productive hours per dispatch or in total hours per dispatch. Average productive hours per dispatch, for example, is 2.37 for technicians in traditional groups and 2.35 for those in self-managed groups. The only consistent difference between TWGs and SMTs is in the distribution of hours. Self-managed team members average about 2 hours less time in productive hours and 1.3 more hours of unproductive hours each month. The greater time spent by SMTs in unproductive hours is consistent with field interviews with SMT technicians who said they hold regular meetings to organize the way they work together. SMTs also undertake more training in group problem-solving and decision-making. An analysis of the data by month and by quarter reveal no significant trends; that is, no particular time period accounts for the differences in the distribution of work hours.

In the full OLS model which estimates the determinants of hours of work and productivity (Table 4), SMTs have the effect of reducing productive hours of work by 2 hours per employee per month. This does not translate, however, into significant differences in productive hours per task. In fact, team membership reduces productive hours per task, but the effect is not significant. Members of SMTs do, however, work 6 more overtime hours per employee per month. In total, therefore, team members spend roughly 8 hours per member per month doing work other than direct customer service[10]. These hours of work estimates are consistent with descriptions from field interviews as well as the evidence on absorption of supervisory tasks from Table 2. SMT members said that the "lead" person (who generally rotated on a monthly or bimonthly basis) would take about 1 day per week to handle assignments, customer complaints, and reporting tasks, or "paperwork," previously handled by the supervisor. In addition, each team member takes on tasks of internal and external coordination of work. While the additional work hours lead to an increase in the total hours per task, the effect is not significant.

TABLE 4
Determinants of Performance of Network Crews:
Hours of Work and Productivity Analysis

	Productive Hours/Mo.	Overtime Hours/Mo.	Productive Hrs/Dispatch	Total Hrs/ Dispatch
Independent Variables				
Work/HR Practices				
SMT membership	-1.97	6.03	-0.07	0.03
	(0.77)	(2.45)	(0.12)	(0.17)
TQM membership	-3.17	-1.05	0.04	0.11
	(1.04)	(2.50)	(0.13)	(0.18)
Technology	0.01	-0.13 +	-0.00	-0.01
	(0.02)	(0.07)	(0.00)	(0.00)
Job enlargement	0.29	1.19	-0.00	0.01
	(0.21)	(0.50)	(0.02)	(0.03)
Training	0.02	0.01	-0.00	-0.00
	(0.05)	(0.11)	(0.01)	(0.01)
Supervisor/coach support	0.46	2.20	0.01	0.04
	(0.53)	(1.43)	(0.10)	(0.13)
Promotion opportunities	-0.25	-1.89	-0.06	-0.11
	(0.37)	(1.09)	(0.06)	(0.08)
Earnings	1. 15E-06	0.00	-1.8E-05	0.00
	(4.48E-05)	(0.00)	(7.27E-06)	(0.00)
Employment Relations				
Work group relations	0.59	-0.79	0.07	0.06
	(0.67)	(1.75)	(0.07)	(0.10)
Labor-mgmt. relations	0.37	0.75	-0.10	-0.12
	(0.54)	(1.32)	(0.08)	(0.11)
Union membership	-0.01	-5.13	0.44	0.55
	(1.00)	(4.14)	(0.11)	(0.14)
Demographics				
Age	0.02	0.18	0.02	0.03
	(0.10)	(0.27)	(0.01)	(0.02)
Gender	-4.16	-5.07	-0.34	-0.41
	(1.69)	(7.02)	(0.43)	(0.56)
Race	-0.24	2.70	-0.22	-0.24
	(1.48)	(3.82)	(0.16)	(0.23)
Tenure	-0.04	-0.32	0.04	0.05
	(0.10)	(0.32)	(0.02)	(0.02)
Education	0.87	1.68	-0.01	0.00
	(0.34)	(1.13)	(0.04)	(0.05)

TABLE 4 (continued)
Determinants of Performance of Network Crews:
Hours of Work and Productivity Analysis

	Productive Hours/Mo.	Overtime Hours/Mo.	Productive Hrs/Dispatch	Total Hrs/ Dispatch
Service Market				
State				
State 1	-1.08	0.39	-0.06	-0.12
	(1.09)	(4.04)	(0.39)	(0.58)
State 2	0.25	-1.25	-0.18	-0.29
	(1.26)	(5.85)	(0.19)	(0.27)
State 3	4.60	7.82	-0.43 *	-0.53
	(1.06)	(5.44)	(0.22)	(0.30)+
State 4	-1.52	-5.70	-0.09	-0.23
	(1.23)	(3.92)	(0.14)	(0.22)
State 5	-0.21	-3.21	-0.47 *	-0.72
	(1.18)	(3.46)	(0.17)	(0.24)
State 6	-0.31	-4.34	0.02	-0.05
	(0.93)	(2.80)	(0.23)	(0.33)
State 7	2.33	-0.02	-0.14	-0.27
	(1.81)	(4.12)	(0.15)	(0.21)
Geographic Location				
Rural	0.15	-0.45	-0.01	-0.03
	(0.83)	(2.89)	(0.12)	(0.16)
Urban	-0.84	-1.99	0.03	0.04
	(1.12)	(3.19)	(0.18)	(0.23)
Customer Base				
Residential	0.93	-0.50	-0.06	-0.06
	(2.20)	(4.26)	(0.28)	(0.35)
Small business	2.92	49.17	-0.52	-0.03
	(2.46)	(18.55)	(0.67)	(0.75)
Constant	139.33	-40.35	2.14	1.77
	(6.36)	(22.59)	(0.78)	(1.01)+
Sample size	185	185	185	185
Adjusted R 2	0.10	0.36	0.13	0.10

Standard errors in parenthesis.

Significant differences: ***=p<.001; **=p<.01; *=p<.05; +=p<.10

To consider the performance outcomes associated with volunteering, I repeated the series of performance and productivity models discussed above, replacing team membership with team volunteer and with new team dummies. There are no significant differences between new teams and old teams in any of the performance outcomes, a finding that suggests that there is consistency and continuity in the team program in this case. The results are not reported here. The results of the volunteer model are presented in Appendix C. In all model specifications, the effects of volunteerism bear no resemblance to the effects of teams, and in some cases, show a directly opposite effect. Volunteers, for example, had significantly more missed appointments and fewer overtime hours, the latter suggesting that volunteers may be motivated to join teams in order to receive more overtime.

Some additional secondary findings are noteworthy. First, in Table 4, it is striking that participation in offline total quality problem-solving teams is a much greater time sink than participation in the teams. Participation significantly decreases an employee's direct labor hours by 3.2 hours per month, but has no positive effect on the variables of interest to management. This finding is consistent with the literature that distinguishes conceptually between participation (employee participation in offline or ad hoc problem-solving with supervisors) and delegation (job redesign, job enhancement, autonomous teams) (e.g., Leana, 1987) -- what others have referred to as various forms of participation (e.g., Cotton, 1993; Cohen and Bailey, 1997). A growing body of empirical studies show that offline problem-solving or employee involvement programs have limited effects on subjective and objective outcome measures (e.g., Batt & Appelbaum, 1995; Cohen & Bailey, 1997; Ichniowski et.al., 1996; Wagner, 1994).

Also noteworthy is the significance of several measures of technology and service market characteristics. Technicians who report using higher levels of new plant and equipment report lower overtime hours and fewer missed appointments. State location variables significantly increase the explanatory power of the models and explain the bulk of the variation in objective outcome measures (missed appointments, multiple dispatches, productive hours, productive hours per task). This suggests that service market strategies, which vary by state, lead to different standards with respect to quality and customer service.

The Distribution of Costs and Benefits

How are the costs and benefits of teams distributed? If team members learn new skills and absorb the tasks of group management, external coordination, and group problem-solving, how much time does it take them to do this work compared to the supervisor? With an average of 8 members per team, and 8 hours per team member per month, teams do the work of supervisors in 64 hours per month. Assuming one full-time supervisor (174 hours per month)[11], a first estimate is that teams accomplish the work of supervisors in 62% less time. However, supervisors also routinely worked overtime, and were paid a straight hourly wage for that time. In my survey, 79% of network supervisors reported receiving overtime or compensatory pay in the previous year. They reported working an average of 9.7 hours per day (9.5 hours per week in overtime), but it is unclear whether they received overtime pay for all or a portion of those hours. Company data from the Human Resources Department show that supervisors received an average of $7,000 per year in added overtime pay, which translates into 26 overtime hours per month (6 per week)[12]. This is less than the supervisors reported, but a reasonable estimate. Taking overtime into consideration, therefore, teams do in 64 hours per month what their prior supervisor did in 200 hours per month, a difference of 68 percent.

Table 5 translates this hours of work analysis into labor costs. The average total cost of wages and benefits of first line supervisors was $73,497 in 1995 (a mid point average salary of $47,000 plus 36% loading for the costs of benefits). The average $7,000 in overtime pay brings the average total costs per supervisor to $80,497. The costs of additional work hours among team members is estimated at 2 hours of straight time (lost direct labor @ $17.50 per hour) plus 6 hours of overtime per member per month. Assuming that the average size of work groups is 8, additional costs for teams for the employer included 16 hours of straight time per month and 48 hours of over time. Labor costs for network technicians average $23.80 per hour in 1995 (loaded estimate including 36% for benefits). The hourly overtime rate is $26.25 (one and a half times the hourly pay of $17.50)[13]. The calculations in Table 5 show that the employer saved $60,780 in indirect labor costs per team per year. Notably, the employer shared the savings with team members -- the employer recognized 75.5% of the indirect cost savings while employees received the remaining 24.5% through longer work hours and overtime pay.

Table 5

Estimated Labor Cost Savings Associated With Self-Managed Teams

Cost Category	**Estimate including Overtime**		**Estimate excluding Overtime**	
Supervisor: annual salary	$73,470		$73,470	
Supervisor: annual overtime*	+7,000		------	
Subtotal	80,470	80,470	73,470	73,470
Cost of team absorption of supervisory tasks (8 members):				
Meeting and training time: 16 hrs/mo @ $23.80/hr * 12mos.	4,570		4,570	-4,570
Overtime: 48 hrs/mo @ $26.25/hr * 12 mos.	+15,120			-------
Subtotal	19,690	-19,690		
Company savings per position		**$60,780**		**$68,900**
Team member share in savings:				
Estimate 1:				
Base pay: $17.50/hr * 2080 hrs/yr	$36,400			
Team-related overtime ($26.25/hr * 6hrs/mo * 12 mos/yr.)	1,890			
% **increase in annual pay**	**5.19**			
Estimate 2:				
Base pay: $17.50/hr * 2080 hrs/yr	$36,400			
Regular overtime ($26.25/hr* 3 0 hrs/mo * 12 mos/yr.)	9,450			
Annual pay	45,850			
Team-related overtime ($26.25/hr * 6hrs/mo * 12 mos/yr.)	**1,890**			
% increase in annual pay	4.12			

Under scenario 1, company realizes 75.5% of savings; employees receive 24.5%.
Under scenario 2, company realizes 93.8% of savings, but may suffer productivity decline.

This overtime pay represents an annual wage premium for team members of between 4.12 and 5.19%, depending upon alternate estimates. Using the annual base pay of $36,400, teams gain 5.19% annually through additional overtime pay. But according to my data, even workers in traditional groups work an average of 30 hours of overtime per month, bringing their average annual wage to $45,850, an amount close to the mean self-reported wages from the survey data of $46,585. Under this second estimate, team members realized a 4.12 premium for team-related work compared to their counterparts in traditionally supervised groups.

One could also imagine a scenario in which the company prohibited overtime pay because of cost constraints. In this case (also Table 5), the employer would recognize more of the cost savings associated with shifting indirect labor costs from supervisors to nonmanagerial workers ($68,900 per position or 94% of the savings). One would also, however, have to revise downward productivity and quality estimates of teams as it is not reasonable to assume that absorption of coordination tasks is costless. Furthermore, in the current context, employees are already equipped with and using computerized information systems for reporting purposes, so that gains from electronic monitoring already have been substantially realized even among the traditionally-supervised groups.

Annual indirect cost savings associated with the team system would depend on the percentage of the nonmanagement workforce that shifts to self-management and the relative increase in the spans of control of firstline supervisors. In the case in question, the team system covered roughly 5% of the technician workforce, but 32% of the survey respondents in traditional groups said they would volunteer for the program if given the opportunity. There were over 3000 firstline supervisors in network operations at the time of the study. If one-third of the workforce shifts to self-managed work teams and the span of control of supervisors of those teams triples (from 8 to 24), then reductions of roughly one-third of the supervisory workforce are possible. A more conservative estimate associated with eliminating one quarter of the supervisory positions is approximately $50 million in annual indirect labor costs.

CONCLUSIONS AND LIMITATIONS OF THIS STUDY

How should this intervention be evaluated? From the perspective of management, it did not lead to improvements in objective measures of quality or productivity, but did achieve managerial objectives of substantially reducing costs. Given significant institutional constraints, management might view this as a success. But was it successful enough? In this case, it was not. Teams already in existence were allowed to continue, but in 1995, management abandoned the formation of new teams in favor of more radical reengineering and downsizing of the organization in preparation for deregulation of local service markets in 1996. This strategy, not dependent on volunteerism, allowed more rapid and across-the-board headcount reductions.

From the perspective of the technicians, they gained new skills and responsibilities, worked longer hours, and received higher wages. There are two ways to view this premium. The first is as a share in the gains of a productivity-enhancing work innovation. In the literature on participation and industrial performance, there are few empirical studies that report wage gains for employees unless there is a formal gainsharing program in place. The example in this case cannot formally demonstrate that overtime pay served as a significant motivator for employees to join or continue in teams, but field interviews indicated that most employees did value opportunities for additional overtime pay (as long as it was not forced or excessive). Additional overtime pay was not formally recognized as part of the team program, but assuming strong social networks among unionized workers, it probably became informally recognized as "part of the deal." Nonetheless, district level budgets set limits on overtime so that excessive abuse was also not "part of the deal."

A second way of viewing the team-related overtime is as a premium for learning and using new skills. In the labor economics literature, for example, empirical research finds growing wage variation within occupational groups, and associates that growth with "skill-biased technological change," broadly conceived. In this case, one could argue that the "technology" is the social technology of reorganizing work that changes the skill requirements of some jobs within an occupation and creates opportunities for greater wage variation within quite homogenous groups.

In sum, this paper contributes to the literature on teams by estimating a model of self-managed teams among skilled technicians. It demonstrates the value of estimating separate performance models that distinguish between quality and productivity outcomes. It also estimates the distribution of costs and benefits for teams and employees. While productivity is a traditional measure that fails to capture quality and other dimensions of performance, it remains a central concern for management at all levels of organizations. Because data on hours of work and labor costs must be kept for legal and accounting purposes, these data are quite reliable and accessible from management information systems. Researchers interested in organizational behavioral would find it relatively simple to incorporate a productivity and cost analysis into their performance models. This type of analysis provides a needed input for interpreting occupation-specific output measures of quality and quantity that are increasingly used in empirical research on teams and group effectiveness, as well as for understanding the distribution of economic benefits associated with innovations.

There are several limitations to this study. First, there are several plausible explanations for the finding of no relationship between teams and objective quality measures. These include technological, organizational, and institutional constraints as well as measurement error. This paper is unable to sort out which causes dominate.

A second limitation concerns the constraints imposed by "objective" company data. Performance data usually capture the full effects of the work system, including technology, work design, human resource incentives, and the effort of individuals, which argues for higher level units of analysis. But in this case, aggregation to a higher level would not have solved measurement problems because of the great variation in technology, which varies with each individual job assignment. In addition, company measures usually miss important dimensions of performance, particularly when work innovations are introduced. In this case, more accurate measures would have included: a) direct customer satisfaction and survey responses; b) extent of preventative maintenance; c) the actual quality of repairs completed; d) innovative approaches to solving problems; e) average cycle time in responding to service orders and customer problem reports. This suggests, as many observers have noted, that companies introducing new forms of work organization need to develop performance measures that capture anticipated results.

A third limitation is that the study involves only one occupational group in one organization. The literature on teams would benefit from comparative studies that analyze the relative economic costs and benefits of self-managed teams across a range of skill groups and industry settings.

FOOTNOTES

[1] Arguments for more research in organizational context are found in Goodman et. al., 1986, 1987; McGrath, 1986; Beekun, 1989; Hackman, 1990; Sundstrom, DeMeuse, & Futrell, 1990; and Cappelli & Sherer, 1991. Goodman and associates particularly emphasize the importance of technology and the production process. Beekun's 1989 meta-analysis of empirical studies of self-managing teams finds large variation in the effects of teams on outcomes of interest, suggesting that such variation is the result of situation-specific context variables.

[2] Guzzo and Dickson, for example, note that the concept of autonomous teams has been around for 50 years, but "there was little momentum for their adoption in US workplaces until the past decade or so as firms reduced levels of management…" (1996: 324); yet few studies consider teams in relation to downsizing and restructuring strategies.

[3] Several early studies do include detailed analyses of productivity, work hours, operational costs, and/or wages (e.g., Trist, Sussman and Brown (1977), Goodman (1979), Cohen and Turney's (1978), Walton (1982), Macy (1982). Wall et. al. (1986) mention indirect cost savings associated with self-managed teams in a confectionery plant, but treat the effect as secondary and do not quantify savings. More recently, Campion and McClelland (1991, 1993) estimate costs associated with enlarged jobs.

[4] According to one internal memo, "...the VSIP [voluntary early retirement supplement] of 1990 and a local fatality began eating away at our Line Supervisor positions. We began to search for ways to manage the business with less supervision and Self-Managed Teams popped up as an alternative. Since that time, I believe we have become front runners in this concept."

[5] While full deregulation of local services is beginning only in the wake of the Telecommunications Act of 1996, alternative access carriers began skimming the most lucrative customers from the Bell companies soon after deregulation of long distance in 1984. The regional Bell companies downsized through attrition until the early 1990s, when they initiated forced reductions and layoffs for the first time.

[6] Because bringing districts into the AMPs data base was a corporate-level systematic effort, there is no reason to believe that the data is biased in a particular way. A comparison of the survey responses of those with and without matched performance data shows that the latter group is different only in that a it has a higher percentage of technicians serving residential and rural customers, and somewhat different proportion of employees by state. These dimensions are not variables of central interest and are controlled for in the performance model.

[7] Other measures of technological modernization (percentage of lead core or copper cable) produced similar results, and are not included in the model.

[8] Logit and probit models are estimated via a maximum likelihood technique that estimates coefficients; logistic regression models are similar but report estimates in terms of probabilities of choice. Since this is not a choice model, a probit model is used. Logit and probit models differ in their assumptions about the error term. Logit models assume that the error terms are independently and identically distributed; this means that it does not distinguish between alternatives that are close substitutes. Probit models assume that error terms are distributed multivariate-normally, allowing error terms to be correlated across alternatives thereby allowing more accurate distinctions across similar alternatives. I tested both logit and probit models in this study, and did not find significant differences in coefficients although there were some

differences in levels of significance. For this study, I report probit results, which provide more conservative significance levels.

[9] I also estimated the Klein model using the entire sample of 373 technicians and found consistent results for teams, volunteers, and new versus older teams. For self-managed teams, I found that the coefficients of the variables measuring vertical, horizontal, and analytical tasks were somewhat smaller but of equal significance. For volunteers, the coefficients were smaller and less significant. For new teams, none of the coefficients were significant.

[10] The coefficient on teams for overtime hours varies slightly under different model specifications, for example, when the omitted category for service market dummies changes. The variation is between 5.2 hours and 6 hours per month. For this analysis, the larger estimate is used.

[11] Supervisory hours = (40 hrs/week * 4.3 weeks/month) = 174 per month.

[12] Supervisory pay: $47,000/year / 2080 hours/year = $22.60 per hour. Assuming supervisors received straight time pay as overtime, $7,000 in overtime pay = 309 hours per year, 26 hours per month, 6 hours per week.

[13] Actual wage data for this study could not be obtained, but there is little variation in wages except for variation associated with the number of overtime hours. This is because the union contract sets hourly wages; wage is by seniority, with employees topping out after 5 years of service. Because this study involves employees who average 22 years of service, with a standard deviation of 5, there is little variation in wages based on seniority.

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