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TEAMS AT NUMMI

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INTRODUCTION

This paper analyzes the team-based organization of work at one auto plant in order to gain insight into the antecedents and consequences of this increasingly common form of organization. My investigation is framed by two puzzling findings, one concerning the prevalence of teamwork in the US economy as a whole, and the other concerning its prevalence in the auto industry. Close analysis of the latter will help clarify the former.

To resolve these two puzzles, I analyze the context and content of teamwork at NUMMI, a joint venture of Toyota and GM whose day-to-day operations are under Toyota control. NUMMI has from its inception adopted the Toyota team-based model of work organization and a broad set of supporting policies and practices. By locating teams in the broader context of NUMMI's employment relationship as a whole, I will highlight some of the NUMMI teams' key features, their promise and limitations, and their wider significance.

TWO PUZZLES

This study is framed by two puzzling findings. The first is the astonishing speed of diffusion of the team form of work organization in the US economy. A survey of the *Fortune* 1000 largest US firms (Lawler, Mohrman, and Ledford, 1995) found that in 1987, 28% of the employees in the sample were in firms that used "self-managed workteams" for at least some employees; by 1995 that 28% ratio had grown to 68%. In 1978, only 6% of employees were in firms that used such teams for between 20% and 40% of their employees; by 1995 that 6% ratio had grown to 15%. These 1995 levels may seem high, but they are broadly consistent with Osterman's (1994) survey which finds that 32% of manufacturing plants use teams for over 50% of their core workforce (i.e. the largest group of nonmanagerial employees involved in producing the establishment's main products).

According to standard contingency theory (Cummings, 1982), whether teams are technically appropriate forms of organization depends primarily on the degree of task interdependence. If this interdependence warrants a team structure, the choice between "traditional work groups" and more autonomous "self-regulating work groups" depends on the degree of uncertainty in the core tasks. The dramatic increase documented by Lawler et al. constitutes a puzzle because, while many observers would agree that the overall state of the business and technological environment is becoming less stable and that some new technologies facilitate or demand teamwork, it is difficult to believe that in the US economy as whole there has been such a substantial, rapid, and widespread shift in the level of task uncertainty or interdependence as to warrant such a substantial, rapid and widespread shift toward self-managed work teams.

The second puzzling finding concerns the contrast between the prevalence of teams in US Big Three auto plants and Japanese transplants. MacDuffie and Pil (forthcoming) report that the percentage of workers organized in work teams among the US Big Three auto assembly plants is very low — 6% in 1993. This result is not surprising to contingency theorists. High-volume auto assembly evidences only modest degrees of task interdependence and task uncertainty, so it is hardly surprising that auto assembly plants rely on "traditional" job designs, where tasks are grouped into functionally independent individual jobs — rather than groups — and are governed by high levels of external control — rather than by internalized employee self-control. There is nevertheless a puzzle here, since Japanese auto transplants have made production teams, albeit in the form of rather traditional work groups, the basis of their organizational model: in the same survey, MacDuffie and Pil find that in 1993 76% of the transplants' workers operated in teams, up from 71% in 1989. The puzzle only deepens when we note that contrary to the trend in the broader economy, the frequency of teams in MacDuffie and Pil's matched sample of Big Three plants had actually fallen to 6% in 1993 from 10% in 1989. (Note however that the difference between the two years may not be statistically significant given the sample size and given the fact that union hostility to some "team concept" programs may make some management respondents hesitate to use the term "teams" to describe their work organization.)

The great difference in teamwork design frequencies between Big Three and transplant assembly plants is a puzzle for contingency theory since tasks in Big Three plants and transplants are essentially identical: producing comparable and high volumes of similarly and only modestly differentiated products using similar equipment. Moreover, using a very different work design, the transplants have in general outperformed their Big Three counterparts in both efficiency and quality. In the sample covered by MacDuffie and Pil in 1993, transplant assembly operations averaged 18.2 hours per car vs. 20 in Big Three, and 56 defects per 100 vehicles vs. 61. Yet even while a broad spectrum of US industry was adopting teamwork, the Big Three made no move toward this higher-performing organizational design, and may have even moved further away from it.

An analysis of teams at one auto assembly plant, the NUMMI facility in Northern California, provides some insight in the advantages and limitations of teams, and can thus help elucidate these two puzzles. My discussion will first identify the contribution of teams to auto assembly production effectiveness; this will then allow us to develop some hypotheses concerning the causes of the adoption of teamwork in other sectors of industry.

A FRAMEWORK FOR ANALYSIS

In order to understand teamwork at NUMMI, this paper uses a heuristic framework developed by the GERPISA "Employment relations" group (coordinated by Jean-Pierre Durand). This framework highlights four key dimensions: the internal organization of the production team, the production process within which the team operates, the nature of the managerial hierarchy, and the modes of worker involvement (see Exhibit).

The following section sketches the history of NUMMI. I then characterize NUMMI under each of the framework headings in turn. To put this discussion of NUMMI in context, I compare this plant with the patterns prevailing in (a) Toyota's Japanese plants, (b) American auto plants, and (c) American industry in general.

My characterization of NUMMI comes primarily from my field research conducted between 1989 and 1994 at NUMMI (various aspects have been reported in Adler 1993, 1995, 1996; Adler and Cole, 1993, 1994; and Adler, Goldoftas and Levine, 1995). Grønning (1992) provides a valuable source on similarities and differences between NUMMI and Toyota operations in Japan.

To characterize the policies and practices found in the broader spectrum of American industry, I rely on several recent surveys. Starting with the most general, Lawler, Mohrman and Ledford (1995) surveyed *Fortune* 1000 companies in 1987, 1990, and 1993. Osterman (1994) surveyed a national sample of manufacturing and non-manufacturing establishments in 1992. MacDuffie and Pil (forthcoming) have developed an extensive data set on auto assembly plants in 1989 and 1993.

THE EMPLOYMENT RELATION

1. Internal team organization:

• division of labor
• job assignments
• Team Leader role

2. Production process:

• work cycles
• methods and standards
• quality control

3. Managerial hierarchy:

• planning authority
• personnel management
• leadership process

4. Worker involvement:

• involvement mechanisms
• union role
• employment security
• wage determination

A BRIEF OVERVIEW OF NUMMI

The NUMMI plant opened in 1984. It was created as a joint venture between Toyota Motor Corporation (TMC) and General Motors (GM). Its mission was to produce small cars for sale by both partners. TMC agreed to invest $100 million, supply the cars' designs, and manage the factory, while GM would provide the building and market half the cars. Each partner was a half-owner of the new company.

The company took over the GM-Fremont plant that had been closed in 1982. Unexcused absenteeism at GM-Fremont had often run over 20%. Quality levels and productivity had been both far below the GM norm, which itself was falling ever further behind the world-class standard then being set in Japan. Labor relations were, in the words of the Bargaining Committee chair, “war.”

It was politically impossible for the plant to reopen without UAW involvement. So although TMC was initially reluctant to work with the UAW, they agreed to recognize the union and to give priority to rehiring the laid-off workers. The selection process was done jointly by the union and management. Notwithstanding the three full days of selection, interviews, and tests, few workers who went through the selection process were rejected. The entire union hierarchy was rehired, and of the 2,200 workers hired by late 1985, over 95% of the assembly workers and 75% of the skilled trades workers were former GM-Fremont employees.

The initial 1985 collective bargaining contract embodied a very different role for the union than in the Big Three plants. The introduction stated that the union and management “are committed to building and maintaining the most innovative and harmonious labor-management relation in America.” Some innovative features of the plant’s human resource policies, including the commitment to the team concept of production organization, supported this commitment.

By 1986, with largely the same workforce and comparable equipment, NUMMI had achieved productivity levels almost twice those of GM-Fremont in its best years, 40% better than the average Big Three assembly plant, and very close to its TMC sister plant in Takaoka. It was also producing the highest quality levels in the industry. In 1989, TMC announced that it would invest another $350 million to expand the plant and begin production of pick-up trucks. This led to the hiring of an additional 700 workers — selected from an applicant pool of 9,000 — bringing total employment up to 3700. By 1995, employment had risen to 4200.

Through the early 1990s, the plant continued to excel in quality and productivity. In 1995, J. D. Power and Associates ranked the Prizm the best built car in North America, the Corolla was number two in the small car segment, and the Toyota HiLux was the best compact pickup truck built in North America.

A number of indices suggest that worker satisfaction and commitment were also high. Researchers who asked NUMMI workers whether they would switch jobs if there were a Big Three plant across the street received responses that were uniformly negative. According to a biannual Team Member survey at the plant, the number of workers who said they were “satisfied with [their] job and environment” increased progressively from 65% in 1985 to 90% in 1991 and 1993. The absence rate (excluding only scheduled vacations) remained around 3%, compared with an average of nearly 9% at Big Three plants in that period, and personnel turnover remained under 6%. Participation the suggestion program climbed steadily of the period and had remained over 90% since 1991.

THE EMPLOYMENT RELATION AT NUMMI

Internal team organization

Teams were a key component of the Toyota Production System implemented at NUMMI. Workers were organized in production teams of five to seven workers under a Team Leader, and four or five teams comprised a group under the first level of management, the Group Leader. While the focus of this paper is on production teams, we should also note that NUMMI workers were also involved in off-line teams, in the form of quality circles (called Problem Solving Circles at NUMMI) and temporary project teams such as the new model introduction Pilot Teams. While PSCs brought workers from the same work area together, project teams often drew workers into cross-functional and sometimes inter-plant collaborative efforts.

Workers were encouraged to master all the jobs in their production team. NUMMI put great value on workers' multifunctionality. In management's view, multifunctionality allowed for greater flexibility in operations and broadened workers' understanding of the production process and thus strengthened their ability to contribute improvement ideas. In this approach, NUMMI followed TMC's example. At Toyota, there was only one production worker classification and one skilled trades classification, and the division of labor between the two was rather fluid, with production workers performing simple preventative maintenance activities and skilled workers sometimes assigned to help out production activities. By contrast, in Big Three US auto plants there were often over 80 production worker classifications and over 18 skilled trades classifications and the division of labor was typically rigid. NUMMI had only three Team Member classifications: production, tool-and-die, general maintenance; within each category, the division of labor was fluid, but there was little overlap of activities between categories.

In order to create multifunctional workers, NUMMI trained workers for the different jobs within their team. Workers were also encouraged to broaden their skills by moving from one group to another and one area of the plant to another over a period of years; but unlike TMC, NUMMI did not have any specific plans governing such skill broadening. Traditional American unionized plants rarely allowed rotation, if only because of the extensively differentiated job classifications. Job changes in US unionized plants were typically determined on a seniority basis, and only rarely did unionized companies encourage, let alone plan, such development. When workers did change jobs, it was at their own discretion and usually for personal reasons such as easier work or more convenient hours (Brown and Reich, 1995).

NUMMI had more intra-day, within-team, rotation than its sister TMC plant. The aims of rotation were to encourage multifunctionality, to alleviate boredom, and to reduce ergonomic strain. Intra-day rotation was only within each production team. The frequency with which teams rotated had, until recently, been left to the discretion of the teams themselves. This, however, led to a gradual decline in the proportion of teams rotating. Some workers continued working with minor injuries and as a result found it hard to rotate into all the team positions. In other cases, workers managed to hold on to easier jobs, sometimes benefiting from a widely shared norm that older or higher seniority workers should have easier jobs. After a spike in injuries brought two "serious" Cal-OSHA citations in 1994, rotation was made company policy (Adler, Goldoftas and Levine, 1995).

The work team was led by a Team Leader who was an hourly worker and a UAW member. Team Leaders were paid a premium of $0.60 per hour. The Team Leader filled in for absent workers, trained new workers, assisted workers having difficulty in their jobs, recorded attendance, assigned work when the line stopped, assisted team members in minor maintenance and housekeeping, assessed new team members, led kaizen efforts, facilitate PSCs, and organized social events outside the plant. Team Leaders were supposed to work on the line some 40% of the time filling in for absent or temporarily reassigned workers.

Team Leader openings were posted. People wanting promotion to Team Leader underwent 20 hours of pre-selection training on their own time, and selection was based on their performance in these classes and in their current jobs. In NUMMI's early years, there were persistent complaints of favoritism in management's selection of Team Leaders; as a result, the union and management negotiated a more formal process in which the evaluation and final selection are conducted by a joint union/management committee. In this new process, seniority was only used as a tie breaker. At TMC, by contrast, promotions were based primarily on supervisors' confidential assessment of the worker's ability and attitude (Grønning, 1992, p. 177ff.).

Unlike some US organizations using self-directed teams, and unlike some socio-technically inspired European approaches to teams, Team Leaders at NUMMI were not selected by the Team Members as "team representatives"; their role was seen as primarily technical — more like a "lead hand." In this, NUMMI followed Toyota's lead, privileging depth of technical expertise over the social and political aspects of team operations. Union leaders concurred with this approach, since from their point of view, union coordinators and committeepeople constituted a sufficient mechanism for interest representation.

Production process

The “team concept” was seen by NUMMI and Toyota managers as one component of the Toyota Production System (TPS). However, all the components of TPS were closely interconnected, weaving together both its various technical features and its technical and social dimensions.

The first component of TPS was the kanban system. NUMMI did not use a computerized scheduling system. Instead, signs (“kanban”) were passed to the upstream department whenever a pallet or dolly needs to be replaced. When no kanban arrived, the upstream department stopped production because no inventory was allowed to build up. Behind this innocuous-sounding innovation lay a fundamental shift in management methods, away from the reliance on work-in-progress inventory as a way to buffer tasks from upstream variability, towards a tightly-coupled system in which problems at any point in the process trigger a halt in production and a burst of problem solving efforts (Schonberger, 1982).

The implications of kanban for workers were considerable. First, since small perturbations stopped the whole line, they occasioned considerable pressure and stress. Second, since up- and down-stream operations were so tightly coupled, the system eliminated any control by the worker or the team over the pace of work. Kanban was at the polar opposite of the system used at Volvo’s Kalmar plant, where buffer inventory was a key mechanism for assuring the autonomy of the production teams (Gyllenhammar, 1977).

The second element of NUMMI’s production system was the effort to assure as stable as possible a production schedule (“heijunka”). In the typical Big Three auto assembly plant, schedules were constantly changing, while at NUMMI, the schedule was stabilized over several months. The logic of the NUMMI approach was that changing production levels meant inevitably that inventory levels would be higher, quality could not be assured, and improvement efforts would be stymied. A corollary of level schedules was “mixed model” production: if for example, the month’s schedule called for 75% of model A and 25% of model B, instead of producing model A for three weeks (or three days) and model B for one week (or one day), NUMMI would alternate three jobs of model A followed by one of model B throughout each day.

From the workers’ point of view, production leveling had three important consequences. First, it reduced the stress associated with schedule changes in a taut production system: in a Just-in-time inventory management system, any changes create a lot of stress as workers scramble to reestablish equilibrium. Second, production leveling minimized the risk of temporary layoff by reducing the risk that part of the work force would be temporarily underemployed. Third, the mixed model scheduling approach meant that it was harder for workers to establish “traction” in the sequence of work gestures: mixed model schedules kept workers alert, and, to put it more negatively, increased workers' cognitive load (on traction, see Baldamus, 1995).

The third element of TPS was "kaizen" — continuous improvement. All NUMMI workers were given training in problem-solving for continuous improvement efforts. Kaizen created important challenges for workers, who were constantly pushed to reduce work times and increase quality. Kaizen happened both through bottom-up worker-initiated mechanisms such as the suggestion program and Problem Solving Circles (see below) and through top-down, management-initiated changes driven by supervisors and engineers. NUMMI management believed that the bottom-up process was important for three reasons: the resulting performance gains, the educational benefits that accrued when workers formulated suggestions and estimated their value, and the positive impact of such involvement activities on workers' morale and on their awareness of a zone of common interests with management.

Visual control, the fourth element of TPS, was set of techniques designed to signal abnormal conditions as rapidly and automatically as possible. Kanban was one form of visual control, signaling the need to replenish inventory. Another key element of visual control at NUMMI was the "andon" board lights that signaled quality problems on the line. Workers pulled a "line stop" cord (or pushed a button) when they encountered a quality problem, thus ensuring that it received immediate attention. The commitment to quality implied by this willingness to sacrifice production was appreciated by workers at NUMMI. But under production pressures, Group Leaders would sometimes immediately re-pull the cord to keep the line going and thus postponing efforts to resolve the underlying problems.

Some researchers have seen in visual control a re-incarnation of Bentham's Panopticon design for prisons (Sewell and Wilkinson, 1992); but the parallel fails since an essential component of the Panopticon was the invisibility of the warden to the prisoners, whereas at NUMMI, the action and inaction of both workers and managers were immediately visible to all. This symmetrical visibility — when associated with the substantial power of the union — meant that visual control served technical and productive purposes more than social control and political purposes.

The final element of TPS was "standardized work." Whereas in the Big Three plants, Industrial Engineers would develop prescribed methods from engineering handbooks, at NUMMI Team Leaders and Team Members were taught the techniques of work analysis — including stopwatch use — and used them to assess alternative work methods. The most effective methods were codified in charts hung beside each workstation. There is little doubt that as a result of standardized work analyses and the constant kaizen process, workers at NUMMI worked harder than they did at GM-Fremont. Standard task times at GM-Fremont were set to as to occupy the experienced worker approximately 45 seconds out of a hypothetical cycle time of 60 seconds. In practice, 35 seconds was not uncommon. NUMMI's norm was closer to 57 seconds out of 60.

The standardized work process was evaluated positively by most workers but negatively by some. Workers appreciated the superior quality of the resulting methods: methods developed with worker input were more appropriate to the real work tasks than methods derived by engineers from handbooks and imposed unilaterally; and the standardized work process was thus experienced as helpful in performing work and in identifying the source of problems. Standardized work on the assembly-line and finer-grained discipline in the supply of parts and tools facilitated traction and alleviated the stress that would have otherwise accompanied the increase in seconds worked per cycle. Many accepted that the competitive survival of NUMMI required an intensification of work relative to the GM-Fremont days. And workers appreciated the political and ethical significance of allowing their participation in defining and refining methods. However, some workers resisted being drawn into what they saw as a technique for speeding up their own work and that of their colleagues.

Several indicators suggest that positive assessments of the overall production system were far more common than negative ones: over 90% of workers participated in the suggestion program, and 90% of workers expressing themselves satisfied with their work environment in anonymous employee surveys. The conjunction of TPS's intense discipline and workers' high satisfaction and commitment strikes some observers as implausible on its face (Parker and Slaughter, 1988). Others see it as evidence of internalized domination, as "hegemonic despotism" (Burawoy, 1985). Without denying the significance of ambivalence and fatalism among workers, I find it difficult to dismiss altogether the evidence of workers' commitment. This commitment can, I believe, be attributed to the relatively participative and "democratic" form of Taylorism as it was implemented at NUMMI, which contrasts strongly with Taylorism's more traditional, autocratic and "despotic" form (see Adler, 1995).

Managerial hierarchy

The first level of management at NUMMI was the Group Leader. Several features of the Group Leader's role distinguished it from that of the traditional American foreman.

First, in keeping with the strong technical role Toyota accords the managerial hierarchy at all levels, NUMMI's Group Leaders had responsibility for tasks that in the US Big Three plants remained industrial engineering staff responsibilities. This reflected Toyota's commitment to the "Training Within Industries" methodology developed in the US during World War Two (Schroeder and Robinson, 1991; Robinson and Schroeder, 1993). In the immediate post-War years, Toyota found itself with the same dearth of engineers as US industry during the War. Toyota was attracted to the solution developed by TWI and formalized in the TWI “Job Methods” program: delegate methods engineering and line balancing tasks to the foreman, and encourage the foreman to perform these tasks in collaboration with experienced workers. The TWI Job Methods program virtually disappeared in the US after the War (except for pockets of “work simplification” programs), but it was embraced by numerous Japanese firms during the Occupation years and continues to exercise enormous influence in Japan. NUMMI inherited the TWI practice, renamed “standardized work,” from the parent company.

Group Leaders were also responsible for some human resource management activities that in many American firms were either ignored or handed off to the Personnel department, in particular, training. At NUMMI, as in all Toyota plants, line managers were responsible for on-the-job training (the Personnel department was responsible for off-the-job training). In this OJT, NUMMI, like TMC, relied on a second component of the TWI program, “Job Instruction.” Toyota’s use of JI has not been discussed much in the research or practitioner literature, but it was seen by management as an essential ingredient of its success. Most American workers learn how to do their job by working alongside a more experienced worker for a short period, after which they are left to improvise and develop their own methods to deal with the demands of the job. Consistent with Taylorism’s commitment to identifying the “one best way” of doing each job, and consistent with its relatively “democratic” form of Taylorism, NUMMI combined Job Methods — which allowed experienced workers to codify the most effective gesture-by-gesture sequence for performing the job, along with the “key points” that explicated the important control items at each step — with Job Instruction — a formalized four-step program for teaching new workers this sequence of steps and their key points.

Group Leaders also took responsibility for some more traditional, administrative and disciplinary functions. NUMMI’s absence policies, for example, were very formalized and rather strict. There was no official distinction between excused and unexcused absences outside annual vacations and other officially sanctioned leaves of absence. After three absences within a 90 day period, the Group Leader submitted a written warning. After three more occurrences within 90 days, the Group Leaders submitted a further warning and the worker must undertake counseling. Three more occurrences led to a final warning and further counseling. Three more occurrences led to dismissal. Dismissals were reviewed by a joint labor/management review committee. Repeated absences were the single most common reason for dismissal.

Group Leaders shared responsibility for many personnel issues with the Human Resources department. At NUMMI as in TMC, the HR department was a political “heavyweight,” whereas in the political landscape of corresponding American firms, the HR department was a minor player. For example, NUMMI’s HR department, like TMC’s, was directly involved in placement, appraisal, and promotions of all management personnel, whereas in the typical US company, HR is involved in the careers of only “high-potential” personnel. The HR department even exercised budgetary control over manufacturing headcount.

The leadership process at NUMMI, as exercised by Group Leaders as well as at higher levels, was also rather different from that found in the typical Big Three plant. In visiting US companies, I have been struck by how rarely meetings include more than two contiguous layers of the hierarchy. If middle managers’ subordinates are included in meetings with superiors, the middle managers will often express concern that the subordinates may be trying to “go around” them, or that the superiors might be “undermining their authority.” By contrast, at NUMMI like at TMC, many meetings included three, four, or even more layers, and as a result, there was probably more “fact-based management” and less covertly political behavior. For example: after each model change, there was a plant-wide meeting to discuss lessons learned. This meeting was typically attended by the President, the relevant vice presidents, general managers, assistant general managers, managers, and assistant managers. Strong points and weak points in the management of the model change were all discussed in this open forum. By contrast with most US firms, this kind of meeting structure was common at NUMMI.

Worker involvement

NUMMI mobilized impressive levels of worker involvement through on-line mechanisms such as the andon cord and standardized work, and through off-line mechanisms such as Problem Solving Circles, other off-line teams, and the suggestion program. We have already discussed the on-line mechanisms; here we focus on the off-line mechanisms and on the broader context that sustained worker involvement.

NUMMI’s Problem Solving Circles were relatively recent, beginning in 1991. Toyota and NUMMI managers thought of QC circles as an advanced practice, requiring deep production knowledge that takes years to acquire; by contrast, American companies often interpret QCs primarily as an employee relations tool (and not surprisingly, the “mortality rate” of these QC programs is very high: see Lawler and Mohrman, 1985). NUMMI’s PSCs were more truly voluntary than at TMC, although participation was expected of workers hoping for promotion to Team Leader positions. PSCs were structured as standing committees based on work Groups (not Teams, as in TMC). Each PSC selected a problem within its area of control. The company paid for members’ lunch, but unlike TMC, NUMMI did not pay overtime for PSC activity. In an average month during 1994, 14% of NUMMI workers participated in the PSC program. NUMMI managers thought this proportion was too low, and attributed it to a high frequency of overtime during that year (averaging one hour a day).

NUMMI workers were also involved in other off-line project teams, such as the Pilot Team mobilized to prepare for model changeovers. The changeover to the 1993 model-year passenger car, for example, started up in early 1992 with eight members; by August 1992, there was a total of two Group Leaders and 32 Pilot Team members drawn from the ranks of the plant Team Leaders (usually one Team Leader per group). Seven months before the start of production at NUMMI, the Pilot Team traveled to Japan to study how the Takaoka plant was building the vehicle. They worked on the Takaoka assembly line to learn how their counterparts had designed the specific jobs in the part of the line for which they were responsible. They worked with TMC engineers, proposing design changes to facilitate production of the somewhat differentiated American models. When they returned from Japan, the Pilot Team brought with them large binders containing illustrations of individual parts and explanations of how they should be assembled. They then experimented in NUMMI's pilot area, modifying this information to fit the specifics of NUMMI's line, and turning it into detailed draft work instructions for production Team Members. They also worked with plant engineers to design the appropriate equipment for each job.

Such "off line" teams are increasingly common in US industry, although the specific case of worker involvement in multifunctional model changeover teams is still rare. Some 65% of Lawler's *Fortune* 1000 sample used off-line teams, and in more than half these cases, they covered over 20% of the workforce. Osterman found that 29.7% of manufacturing plants he surveyed used QCs for over 50% of their core workforce. For the auto sector, MacDuffie and Pil found that in 1993, 90% of workers in Japanese plants participated in some kind of employee involvement group; the comparable figure for Japanese transplants in the US was 14%; and for US manufacturers, the ratio was 20%.

Alongside the PSC system, NUMMI put great emphasis on individual and team suggestions. Like TMC, NUMMI management's primary goal was increasing participation — unlike the focus on a few big suggestions that prevails at most American programs. By 1994, well over 90% of workers were participating. Like TMC, the suggestion system was run by Group Leaders with very light administrative support — unlike the more typical American pattern where the program is run by a specialized staff. Moreover, consistent with the goal of encouraging participation, considerable effort was made to explain to workers the nature of the evaluation process and its criteria, and to assure rapid processing of suggestions — on these dimensions too, NUMMI differed from most American firms. MacDuffie and Pil found that whereas Japanese auto manufacturers received on average 48 suggestions per employee per year, with an acceptance rate of 90%, the comparable figures for Big Three plants was 0.2 suggestions per employee and 34% accepted. NUMMI workers contributed around 8 suggestions per employee and around 80% were implemented.

What were the sources of NUMMI's considerable success in mobilizing worker involvement? A number of factors appeared to be operative. First, alongside workers' involvement in production there was a parallel structure that assured workers' involvement in plant governance. NUMMI and UAW Local 2244 put into place an extensive set of joint committees. There were weekly meeting between management and the union Bargaining Committee, weekly safety committee meeting, weekly meetings between section managers and committeepeople, and quarterly three-day off-site meetings between union and company leaderships. The relations between management and union have been largely cooperative. In recent years, the Administration Caucus had been displaced by the People's Caucus (with the exception of the Local President, who is affiliated with the Administration Caucus). The People's Caucus sought a more assertive role, and criticized Administration Caucus for "being in bed with management." It drew relatively stronger support from the newer, younger workers hired with the start-up of the truck line. Symbolizing the Local's new assertiveness, there was a two-hour strike during the contract negotiations in 1994. But in substance, relations between union and management have remained largely cooperative.

One facet of the union's involvement in governance was through its role in assuring an equitable treatment of worker grievances. NUMMI's "Problem Resolution procedure" resembled TMC's in its emphasis on joint problem-solving in the first step, but the three subsequent steps brought it closer to the traditional formalized UAW-Big Three model with external arbitration as the final step. The collective bargaining agreement also differed from standard practice in specifying that there was no recourse to an arbitrator over standardized work or health and safety issues. Instead, in case of unresolved disputes in these matters, "Either party may call upon the UAW Regional Director and W. J. Usery for final resolution of the problem" (1994 Collective Bargaining Agreement, p. 163; Bill Usery is a mediator who was instrumental in forging the initial agreement with the UAW).

A second factor in mobilizing worker involvement was the threat of unemployment. Brown and Reich (1989) cite data from the California Employment Development Department indicating that 40% of the displaced GM-Fremont workers were still unemployed at the end of 1983, and that displaced workers who did find other jobs experienced pay cuts averaging approximately 40%. There were no comparable union-scale jobs to be found in the region then, and none materialized in the intervening years. NUMMI was tied to the national pattern of Big Three/UAW wage rates, and over the intervening years there had been no reduction in the size of the premium separating NUMMI wage levels from those of alternative job opportunities. Workers who could bear the considerable physical and mental demands of work at NUMMI thus had little incentive to leave, and personnel turnover at NUMMI averaged less than 6%.

Employment security against the temporary layoffs so common in Big Three was a third factor buttressing workers' involvement. Employment security was written into NUMMI's collective bargaining agreement :

> "New United Motor Manufacturing, Inc. recognizes that job security is essential to an employee's well being and acknowledges that it has a responsibility, with the cooperation of the Union, to provide stable employment to its workers. The Union's commitments in Article II of this Agreement are a significant step towards the realization of stable employment. Hence, the Company agrees that it will not lay off employees unless compelled to do so by severe economic conditions that threaten the long term viability of the Company. The Company will take affirmative measures before laying off any employees, including such measures as the reduction of salaries of its officers and management, assigning previously subcontracted work to bargaining unit employees capable of performing this work, seeking voluntary layoffs, and other cost saving measures."

NUMMI did not have a Supplemental Unemployment Benefit fund of the kind found at the Big Three (which supplements the meager unemployment benefits available in the US); so this commitment was very important in assuring workers' income stability. NUMMI lived up to the commitment in 1987-88, when capacity utilization fell to under 60% but no one was laid off. Workers were put into extra training programs and were put to work on kaizen projects and facilities maintenance jobs previously contracted out.

Unlike TMC and many "high-involvement" American plants, NUMMI did not use individual or team performance pay incentives, nor skill-based pay. Management's assessment was that such incentives would undermine the teamwork they sought to encourage. Two exceptions to this philosophy proved the rule. The suggestion system did offer financial rewards based on the savings generated, but the amounts were very modest, with the average suggestion earning its author around $25, and the reward was greater for a suggestion coming from a team than for the same suggestion coming from an individual. NUMMI also had a gainsharing-type program (PIPS), introduced in 1991, but it paid all workers identical amounts based on the company's quality and productivity improvement. In 1992, each worker received $1600.

The main avenue for pay progression was promotion to Team Leader. All Team Leader positions and about 80% of Group Leader positions were filled from within. A secondary avenue was the skilled trades apprentice program. The apprentice program began in July 1987, and the UAW offered a 10 week pre-apprenticeship training program. Of some 209 workers who applied for the apprentice program, 43 were finally selected. By 1995, a total of 88 workers had entered the apprenticeship program and 53 had graduated.

Peer pressure was a final factor explaining NUMMI's success in mobilizing worker involvement. Whereas American firms' teams often have 15, 20 or even 25 members, NUMMI followed Toyota's model and kept teams to between four and six members so as to maximize the social interdependence created by work interdependence. Peer pressure has often been presented in a negative light, as a manifestation of internalized domination (see for ex. Barker, 1993). But NUMMI workers' descriptions leave me skeptical that it can be reduced so neatly. To quote one worker:

> "Once you start working as a real team, you're not just work acquaintances any more. When you really have confidence in your co-workers, you trust them, you're proud of what you can do together, then you become loyal to them. That's what keeps the absenteeism rate so low here. When I wake up in the morning, I know there's no one out there to replace me if I'm feeling sick or hung-over or whatever. Not like in the old Fremont plant where they had 20% more people than they should have needed just to cover absences. At NUMMI, I know my team needs me. They need my loyalty like I need theirs."

Cooperation is a spontaneous, anthropological fact; it does not cease having this quality merely because its fruits are appropriated or because more complex forms of organization are erected alongside and on top of it.

THE DYNAMICS OF DIFFUSION: SOME HYPOTHESES

To return to the two puzzles framing this paper, why did NUMMI and other transplants use teams so extensively where Big Three plants did not? My analysis of teamwork at NUMMI and its role in the overall structure of the employment relation suggests three factors. Further research will be needed to assess this argument and whether these factors are equally pertinent at other transplants.

First, as a matter of history, NUMMI used teams because NUMMI was managed along Toyota lines, and teams were a key component of the Toyota production system. In some policy domains (such as benefits), NUMMI adopted American-style policies, and in some other domains (such as grievances), NUMMI hybridized American with Japanese approaches, but in domains that were part of the plant's "productive core," Toyota's policy was that its overseas subsidiaries had to conform to the Toyota production system (see Adler, 1996).

Second, NUMMI used teams because managers saw the production task as embodying high levels of interdependence and modest but not insignificant levels of uncertainty. Like TMC, NUMMI's managers saw assembly-line work tasks as embodying considerable interdependence: while the assembly-line technology minimized the interdependence of work tasks within a given cycle, interdependence was high across cycles when workers rotated tasks or models changed; moreover, looking beyond the immediate production task, interdependence was high in the tasks of defining and refining standardized work charts and PSC activity; and finally, management consciously used team structures and extra-work team activities to create social interdependence. Task uncertainty was also significant: whereas managers at the Big Three traditionally assumed that the production task in auto assembly was so routine that workers could be trained in a day or so, NUMMI's managers inherited from the parent company the assumption that workers' tasks embodied a significant level of uncertainty, thus motivating a continued high emphasis on kaizen. NUMMI thereby created (or "enacted" in the sense of Weick, 1979) a different task environment, one with a higher degree of uncertainty than their Big Three counterparts. Through kaizen, the production task was continually reanalyzed to generate an ever-deeper knowledge and ever-more effective technical control. As a result, NUMMI's teams, while far from the "self-regulating" variety favored by socio-technical theory proponents, were not entirely under the external control that characterizes the "traditional work group" model. The resulting performance gains legitimated and reinforced these initial assumptions of high task interdependence and modest uncertainty.

Third, the teamwork approach to production was not only symbolically and technically legitimate in the eyes of NUMMI managers because of its association with TPS, but it was also seen as posing few risks to control. While over many decades Big Three managers consciously sought to individualize jobs in the name of managerial control over the shop-floor, NUMMI operated on the assumption, once again inherited from their parent company's experience, that under the right social conditions, workers' interdependence can be harnessed to productive ends without undermining social or technical control. NUMMI thus created a different socio-political environment within the plant, one that attributed great importance to "mutual gains" for management and labor and that made such gains seem within reach. This attribution represents a more novel feature of NUMMI's approach, since in Toyota's Japanese plants, social control could rely to a greater extent than was possible in the US on a cultural norm of "groupism" (Lifson, 1992); at NUMMI, mutual commitment was based on a more calculative, bargaining model. When performance benefits manifested themselves in the form of world-class and continuously improving efficiency and quality levels and in the corresponding benefits to workers — enhanced job security, bonuses, and the psychological rewards of "self-efficacy" (Bandura, 1977) — these benefits reinforced the credibility of the initial mutual-gains assumption.

If these three factors help explain why NUMMI used teamwork, why have the Big Three not followed the example of NUMMI and the other transplants — why have they not adopted teamwork too? This is all the more puzzling when it is recalled that all three of the US manufacturers have North American joint ventures with Japanese companies which use teams and perform very well. Moreover, MacDuffie and Pil's data show that between 1989 and 1993, the US Big Three have made as little change to other dimensions of work organization as they have in their use of teams. The contrast is striking with European-owned plants in Europe, where change in work organization has been massive: the ratio of workers in production teams, for example, leapt from 0.4% to 75% between 1989 and 1993.

One possible explanation emerges from MacDuffie and Pil's performance data: while the gap between the Big Three and both the transplants and Japanese plants remains important in both productivity and quality, the Big Three have made large gains and have narrowed somewhat these gaps — and they have done this by making changes to the more technical elements of their production systems but without making substantial change to their work organization. Pil and MacDuffie (1995) review a number of theories (such as March's theory of competency traps, and Argyris and Schon's theory of organizational learning) that predict that when organizations are able to respond to performance pressures without making radical organizational changes whose implementation is difficult and uncertain, they will take the easier route even if the results are only partially adequate.

This proposed resolution of the one puzzle suggests a possible resolution of the other, the rapid diffusion of teamwork across firms in the broader spectrum of industries. Many US firms under pressure from new domestic and foreign competitors have been jolted from their complacent assumption that they have been operating at or close to the production possibilities frontier. They have recognized that their organizations harbored a lot of slack that they now cannot afford, and that they must identify and root out this slack. Data on the differential adoption of new forms of work organization across industries supports the hypothesis that the intensity of domestic and foreign competition is a key driver of work redesign (Lawler et al., 1995, section 17; Osterman, 1994). In some cases, managers' centralizing instinct is too strong, and they have adopted heavy-handed, top-down "business process reengineering" approaches. The high frequency of failure of this path has rapidly discredited it. In many more cases, however, US managers have acknowledged that slack cannot be identified and remedied without considerably greater employee involvement. Simultaneously, the current ideological climate in the US, the persistent employment insecurity, and the declining threat of unions give managers a greater level of assurance that a modest degree of employee self-regulation and more extensive teamwork can be pursued without the risk of losing control. Re-interpreting their organizations' key tasks as embodying higher uncertainty and greater interdependence than they saw in them in the past, managers have thus discovered the virtues of teamwork.

This interpretation is rather different from that implied by theories of cycles of control advanced by Ramsay (1977) and by Barley and Kunda (1992). As opposed to the pendulum swings described by these accounts, my interpretation attributes considerably greater significance to the real productive efficiency of teamwork: insofar as firms are put under competitive pressure, the move toward teamwork appears less like a pendulum swing and more like a step forward along a development path that may be difficult to reverse. The two stories are not entirely incompatible however. It would seem likely that long-term progress along such a development trajectory would indeed be accompanied by cyclical swings around that trajectory. A test of this hypothesis would be provided by a closer analysis of the data on which Ramsay and Barley and Kunda rely, to see whether in the later swings, it was really a matter of returning to an earlier state or if instead the historical process appeared more like a spiral in which the reappearance of old tropes in management discourse and practice was accompanied by significant long-term shifts of focus.

But why is the shift to teamwork in US industry been so sudden? One hypothesis for future research to explore is that while the competitive pressures may have built up gradually over two decades or more, changes in work organization follow a non-linear process. This non-linearity results from two complementary effects. First, there is the threshold effect: it is only when the symbolic legitimacy of teams in the eyes of American managers reached a critical threshold that they were willing to take on the difficult task of the broad-ranging organizational change required to make teamwork effective (Lawler et al, 1995; Jenkins, 1994). Second, there is the contagion effect: managers are far more likely to find arguments in favor of new forms of work organization compelling when these arguments are based on examples from firms that they believe are directly comparable to their own, either as peers or as competitors. It is well established in the network theory literature (Burt, 1982) that given threshold and contagion effects, changes in population characteristics are typically rather abrupt.

REFERENCES

Adler, P.S., 1995, "'Democratic Taylorism': The Toyota Production System at NUMMI," in S. Babson (ed.) Lean Work: Empowerment and Exploitation in the Global Auto Industry, pp. 207-219, Wayne State University Press.

Adler, P.S., 1993, "The Learning Bureaucracy: New United Motors Manufacturing, Inc." in Barry M. Staw and Larry L. Cummings (eds.) Research in Organizational Behavior, vol. 15, pp. 111-194, Greenwich, CT: JAI Press.

Adler, Paul S. 1996, "Hybridization: HRM policies at two Toyota transplants," working paper.

Adler, P.S. and B. Borys, 1996, "Two types of bureaucracy: coercive versus enabling," Administrative Science Quarterly, 41, 1: 61-89.

Adler, P.S. and R. Cole, 1993, "Designed for learning: A tale of two auto plants," Sloan Management Review, 34, 3: 85-94.

Adler. P.S. and R. Cole, 1994, "Rejoinder," Sloan Management Review, 35, 2: 45-49.

Adler, Paul S., Barbara Goldoftas, and David I. Levine, 1995, "Ergonomics, Employee Involvement, and the Toyota Production System: A Case Study of NUMMI's 1993 Model Introduction." Center for Research on Management Working Paper OBIR-64, University of California, Berkeley Business School.

Baldamus, William, 1951, Efficiency and Effort, London.

Barker, James R., 1993, "Tightening the iron cage: concertive control in self-managing teams," Administrative Science Quarterly, 38: 408-437.

Barley, Stephen R., and Gideon Kunda, 1992, "Design and devotion: Surges of rational and normative ideologies of control in managerial discourse," Administrative Science Quarterly, 37: 363-99.

Brown, C. and Reich, M., 1989, "When does cooperation work? A look at NUMMI and GM-Van Nuys," California Management Review, 31, 4: 26-37.

Brown, Clair, and Michael Reich, 1995, "Employee voice in training and career development," paper presented at the IRRA meetings, Washington DC.

Burawoy, Michael, 1985, The Politics of Production, London: Verso.

Burt, R.S., 1982, Toward a structural theory of action, New York: Academic Press.

Cummings, Thomas, 1982, "Designing work for productivity and quality of work life," Outlook, 6: 35-39.

Dow, G.K., "The Function of Authority in Transaction Cost Economics," Journal of Economic Behavior and Organization, 8, 1987, pp. 13-38.

Draper, H., 1984, The Annotated Communist Manifesto, Berkeley CA: Center for Social History.

Grønning, Terje, 1992, "Human value and 'competitiveness': on the social organization of production at Toyota Motor Company and New United Motor Manufacturing, Inc." Diss., Ritsumeikan University Graduate School of Sociology.

Hackman, J. R. and Oldham, G.R. Work Redesign, Reading MA: Addison-Wesley, 1980.

Jenkins, Alan, 1994, "Teams: from 'ideology' to analysis," Organization Studies, 15, 6: 849-60.

Kenney, Martin, and Florida, Richard, "Beyond Mass Production: Production and the Labor Process in Japan," Politics and Society, 16, 1, 1988, pp. 121-158.

Lawler, Edward E., III, Susan A. Mohrman, and Gerald E. Ledford Jr., 1995, Creating High Performance Organizations, San Francisco: Jossey-Bass.

Lawler, Edward E., III. and Susan A. Mohrman, 1985, "Quality circles after the fad," Harvard Business Review, 85, 1: 64-71.

Lawrence, Paul R., and Jay W. Lorsch, 1967, Organization and Environment: Managing Differentiation and Integration, Boston, MA: Harvard University Graduate School of Business Administration.

Lifson, Thomas B., 1992, "Innovation and institutions: notes on the Japanese paradigm," in P.S. Adler (ed.) Technology and the Future of Work, New York: Oxford University Press.

Lincoln, James R., and Arne L. Kalleberg, 1991, Culture, Control and Commitment, Cambridge: Cambridge University Press.

MacDuffie, John Paul, and Frits K. Pil, forthcoming, "International trends in work organization in the auto industry," in L. Turner and K. Wever (eds.) The Comparative Political Economy of Industrial Relations, IRRA.

Osterman, Paul, 1994, "How common is workplace transformation and how can we explain who adopts it?" Industrial and Labor Relations Review, Jan.: 175-188.

Parker, Michael, and Jane Slaughter, 1988, Choosing Sides: Unions and the Team Concept, Boston: South End Press.

Pil, Frits K. and John Paul MacDuffie, 1995, "The determinants of diffusion of high performance work practices: Forces for change in the world auto industry," Wharton School, University of Pennsylvania.

Ramsay, Harvie, 1977, "Cycles of control: worker participation in sociological and historical perspective," Sociology, 11, 3: 481-506

Robinson, Alan G., and Dean M. Schroeder, 1993, "Training, continuous improvement, and human relations: The U.S. TWI programs and the Japanese management style," California Management Review, Winter: 35-57.

Schonberger, Richard J., 1982, Japanese Manufacturing Techniques, New York: The Free Press.

Schroeder, Dean M., and Alan G. Robinson, 1991, “America’s most successful export to Japan: Continuous improvement programs.” Sloan Management Review, Spring: 67-81.

Sewell, Graham and Barry Wilkinson, 1992, “Someone to watch over me: Surveillance, discipline and the Just-in-time labour process,” Sociology, 26, 2: 271-289

Weick, Karl, 1979, The Social Psychology of Organizing, Addison-Wesley, 2nd ed.

Womack, James, Daniel Jones and Daniel Roos, 1990, The Machine that Changed the World, New York: Rawson Associates, MacMillan Publishing Company.