Work System Innovation among Japanese Transplants in the United States

Davis Jenkins
University of Illinois

Richard Florida
Carnegie Mellon University

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Davis Jenkins
Great Cities Institute
University of Illinois at Chicago
322 S. Green Street, Suite 108
Chicago, IL 60607
(312)996-8059 (tel)
(312)996-8933 (fax)
davis@uic.edu

Richard Florida
Center for Economic Development
Carnegie Mellon University
5000 Forbes Avenue
Pittsburgh, PA 15213
(412)268-8784 (tel)
(412)268-5161 (fax)
rlflorida@aol.com

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ABSTRACT

This chapter examines the extent to which Japanese manufacturing plants in the U.S. have adopted approaches to managing production work at are commonly associated (though not always accurately) with manufacturing practice in Japan. Our analysis is based on the first survey of the production work practices of the population of Japanese-affiliated manufacturing plants in the U.S.—the so-called Japanese "transplants." The results of this survey reveal that there is considerable variation among the U.S.-based Japanese transplants in their methods of managing production work. At one end of the spectrum, many transplants have adopted a set of practices that are "innovative" in that they are correlated with the level of manufacturing process improvement activity in the plant. The practices that comprise this innovative work system model reflect a blending of Japanese and American influences. At the other end of the spectrum, a sizeable proportion of the transplants manage production work using "Taylorist" methods characteristic of traditional heavy industry in the U.S. We find that the adoption of innovative work systems is significantly more prevalent among transplants involved in the supply of components and other products for use in automobile production than among transplants not involved in automobile manufacturing. This finding is important because the literature on work organization among the transplants has been heavily influenced by studies of the automobile sector. Further, we find evidence that the innovativeness of the automomtive transplants may be due less to direct Japanese influence than to prevailing practice in the U.S. automobile industry, of which Japanese manufacturers are now a significant part.

INTRODUCTION

In 1972, Sony opened a television plant in San Diego, ushering in an era of expanding investment by Japanese companies in U.S. manufacturing operations, or what are often referred to as the "transplants." The amount of new investment by Japanese companies in U.S.-based manufacturing transplants reached flood proportions in the mid-1980s, peaking in 1989 at around $9 billion. During the early 1990s, Japanese direct investment in U.S. manufacturing declined precipitously in line with the overall decline in foreign direct investment in the U.S. that accompanied recessions in the U.S., Europe and Japan. Since then, such investment has rebounded somewhat, especially as Japanese companies have expanded production in existing facilities. It is not likely to return to the heady levels of the 1980s any time soon, however, in part because Japanese firms are now directing an increasing share of their foreign investment to Asia (Ministry of Finance 1995).

Nevertheless, the transfer to the U.S. of Japanese manufacturing might remains an important factor for U.S. industrial competitiveness, not just because of the magnitude of the investment to date, which has created jobs for American workers and new business opportunities for U.S.-based suppliers, but because of what Japanese manufacturers have to teach U.S. industry. Foremost among the knowledge that Japanese manufacturers bring to the U.S. is expertise in innovative methods for managing production work. These practices are regarded as a key source of the competitive advantage that Japanese companies in industries such as automobiles and electronics have enjoyed in recent decades (see, for example, Womack et al. 1990). Some see such practices as the foundation for a new and superior form of capitalist industrial organization (Lazonick 1990; University of Tokyo 1990; Abo 1993; Kenney and Florida 1993).

Even as investment by Japanese companies in U.S. transplant operations has moderated, U.S. manufacturers have been rushing to implement new approaches to managing production work that are commonly associated with manufacturing in Japan. Some of the practices involved in these new work systems, which are referred to by various labels such as "flexible" and "transformed," and "high performance," are actually quite foreign to manufacturing practice in Japan. They are associated with Japan because, in their broad designs, they resemble the work organization characteristic of large Japanese automobile and electronics manufacturers in a number of respects. Among these are their tendency to organize front-line production workers in groups or teams, to involve production workers in decisions regarding job design and quality control, and to stress the skill-upgrading of workers at all levels. Moreover, used in concert with one another as a system, these practices are designed to foster continuous improvement in the performance of the production system, a process of innovation that is often referred to by the Japanese term *kaizen*.

As a result, there has been intense interest in ways in which Japanese manufacturers manage production work in their U.S. transplant operations. Most of the research on this topic has revealed a varied pattern of transfer and adaptation. A series of comparative case studies by the University of Tokyo (1990; Abo 1993) found that the approach to work organization among the transplants differs by industry, with automotive-related transplants exhibiting a greatest propensity to transfer Japanese practices to the U.S., while electronics transplants tend to emulate U.S. practices and thus adapt to the U.S. environment. In general, the study revealed a tendency to create a "hybrid factory" organization reflecting a mix of Japanese and American approaches. Similar conclusions were reached by a study of Japanese transplants in the United States and Europe by Fujimoto, Nishiguchi and Sei (1994), who found evidence of transfer of Japanese-style production management practices, but noted that practices associated with labor markets—recruitment, training, promotion, wage systems and labor relations—tend to conform to the local environment. Case studies by a team from Michigan State (Cutcher-Gershenfeld et al. 1995) showed that Japanese transplants differ markedly in their approach to implementing work teams. The Michigan State team attributed these differences to a number of factors, including the nature of the production process, whether the plant was wholly Japanese-owned or a joint venture, and whether it was a new plant or an older acquired facility.

The literature on the transplants has been heavily influenced by studies of the automobile sector, and, to a lesser extent, electronics—both sectors known for their innovative approach to work organization in Japan. Most of the research on the transplants has relied on case studies, with several of these studies focusing on a single case: the NUMMI joint venture between Toyota and General Motors (Krafcik 1986; Brown and Reich 1989; Adler 1993a; 1993b; Wilms et al. 1995). The handful of surveys to date have been confined to a single industry or sector (see e.g., Milkman 1991; Florida and Kenny 1991; Kenney and Florida 1992; MacDuffie 1994; MacDuffie and Pil 1994). Hence, there has not been data from which to make generalizations about the pattern of innovation across the broad range of industries in which Japanese companies have transplants operations in the U.S.

This paper examines the management of production work among Japanese transplants across the full range of industries in which Japanese manufacturers have a significant presence in the U.S. To do so, it reports the results of the first survey of the production work practices of the population of Japanese transplants in the U.S. Also included in the survey were a sample of U.S.-owned plants that serve as suppliers to the Japanese automotive assembly transplants. These data allow us to compare the pattern of practice among transplants with that among U.S. plants that are involved in similar activities and have relations in some cases with the same focal organizations (i.e., Japanese transplant customers).

We can not make definitive claims about the *transfer* by the transplants of Japanese work organization to the U.S. because we lack data on the practices of a comparable set of manufacturing plants in Japan. Instead our focus is on the extent to which U.S.-based Japanese transplants have adopted innovative approaches to managing production work that are commonly associated with manufacturing practice in Japan, but that may in fact reflect a blending of Japanese and American practices. Recognizing that there is likely to be wide variation in practice, we also attempt to identify distinct approaches to organizing work among the transplants and to understand the factors that underlie the decision to adopt one approach versus another.

Following a summary description of the survey data, we present a model of work system innovation that enables us to test empirically which innovative practices the Japanese transplants and their U.S.-owned suppliers are using in conjunction with one another in managing production work on the factory floor. We then categorize the plants in our survey sample according to extent to which they are and are not using these innovative practices in conjunction with one another as a "work system," and examine how the pattern of work system innovation differs among the transplants across industries and industry sectors and between the transplants and their U.S.-owned suppliers.

THE DATA

The data were collected through a 1994 survey by the authors of the entire population of Japanese transplants in the United States. The survey obtained plant-level data on organizational practices, supplier relations, plant characteristics, and performance. Transplants are defined as establishments that are either wholly Japanese-owned or have a significant level of Japanese participation (at least 20% ownership) in cross-national joint ventures.

The survey was administered to the population of Japanese transplants in the U.S. and a smaller sample of U.S.-owned suppliers to the automotive transplants. The sampling frame for the survey was based on the 1993 Japan External Trade Organization (JETRO 1993) database and supplemented with information from other sources.[1] The sample of U.S. suppliers was drawn from the ELM database on U.S. automotive suppliers, and supplemented by data from the U.S. Department of Commerce on U.S.-owned suppliers to the Japanese transplants. The survey was administered by the Center for Survey Research at the University of Massachusetts-Boston in two phases: the first involving a mail survey and the second relying on telephone interviews. Based upon an initial screening, 238 transplants were found to be ineligible for the sample, resulting in a sample size of 1,195 transplants and 338 U.S.-owned suppliers to the transplants.

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[1] These included the list of Japanese-affiliated plants in the U.S. as of 1990 compiled by the Japan Economic Institute (MacKnight 1992), directories of Japanese-affiliated companies operating in the U.S., such as Toyo Keizai (1993), and various newsletters, news articles and other publications.

The intended respondent was the plant manager, although in some cases the survey was filled out by a manufacturing manager or human resource manager. There are indications that in more than one case the survey was completed by individuals from multiple departments. A total of 601 surveys were completed and returned, for a response rate of 40.1 percent.

Field research was conducted at a small sample of transplants and U.S.-owned manufacturing plants. Interviews were conducted with managers, engineers, and staff in production, purchasing, and human resources. The research team also observed the production process at each site, where possible talking with workers on the production floor. The field research played an important role in shaping the questions and hypotheses examined by analyzing the survey data.

JAPANESE TRANSPLANTS AND THE NEW WORK SYSTEMS

Much of the previous research on work organization and the transplants has focused on the adoption of particular practices considered to be "innovative." More recent thinking and research on innovative forms of work organization stress the value of examining the use of sets of work practices in conjunction with one another as a "work system." We begin our analysis by looking at individual practices, but then broaden the focus to systems of innovative work practices.

Table 1 compares the adoption of "innovative" work practices by the Japanese-affiliated manufacturing plants that responded to our 1994 survey with that by manufacturing plants in Osterman's 1992 survey of work organization among a sizestratified sample of establishments in the U.S.[2] This comparison allows us to see the extent of use of particular innovative practices among Japanese-affiliated manufacturing plants in the U.S. compared to that among a representative sample of manufacturing plants in the U.S. Overall, the transplants were more likely to use innovative methods for managing production work than were manufacturing plants in the U.S. generally.[3] The only exception is that U.S. manufacturing plants generally showed a greater propensity to use self-directed worker teams. It is important to note, however, that our survey used a more restrictive definition of "self-directed teams" than did Osterman's.[4] The transplants were also more apt to complement innovative approaches to managing production work on the shop floor with supportive human resource policies. For example, the transplants were more likely than their U.S. counterparts to make a no-layoff pledge to their production workers, to provide production workers with off-the-job training and to remunerate workers for skills and knowledge developed on the job.

[Table 1 about here]

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[2]Osterman's sample was limited to establishments with 50 or more employees. Osterman's survey was conducted by telephone, resulting in a response rate of 65.5%.

[3]Note, however, that Osterman's survey was conducted two years prior to ours. It could be the case, therefore, that in the interim the plants in Osterman's survey have "caught up" to those in our sample in the extent to which they use these practices.

[4]In his survey, Osterman simply asked respondents whether their establishment has "self-directed teams," and what percentage of "core employees" (in manufacturing plants, this refers to blue-collar production workers) participate in such teams. Our survey asked a series of questions about the roles and responsibilities of work teams at a plant and then requested respondents to estimate the percentage of production workers who regularly work in such teams. Only if a respondent indicated that "each team has a leader who is a production worker (not a supervisor)" did we consider teams to be "self-directed." Similarly, Osterman's survey does not distinguish between rotation of workers *within* work groups and *between* work groups. Our survey was designed to get at this distinction, since the literature indicates that it may be important. For example, Cole (1989) argues that rotation *within* a work group helps to relieve boredom and prevent repetitive stress disorders, but it does not promote multi-skilling and "systems thinking" to the extent that rotation *between* work groups does.

Some of the practices listed in Table 1 are found in plants of large Japanese manufacturers in Japan (particularly those in automobiles and electronics)—for example, "quality circles," in which production workers meet "off-line" to discuss problems with production processes. Others are more likely American adaptations of Japanese practices or ideas. For example, the "self-directed team," in which production workers carry out their work under the direction of a team leader who is a production worker rather than a supervisor, is more an American invention than an Japanese one, although it reflects the Japanese approach of involving front-line workers in designing work methods and contributing to the improvement of manufacturing processes. Similarly, pledging not to lay off production workers (except in dire circumstances) can be seen as an effort to recreate in the U.S. labor market environment the "permanent employment" for core manufacturing workers that has been a prominent feature of labor relations in large companies in Japan. This supports the findings of previous research that the approach of the Japanese transplants to managing production work reflects a transfer of some practices from Japan and a borrowing of other practices of American origin.

This hybridization of work organization by the Japanese transplants has led to varying conceptions of what is "innovative" about the transplants' approach to managing production. At least two points of consensus emerge from research on the work practices of Japanese manufacturers in Japan and abroad and the larger literature on new forms of work organization. First, "innovative" work practices are those that foster the improvement of organizational performance over time. Scholars of Japanese industrial organization have argued that the propensity to promote continuous improvement of organizational systems, or what is sometimes called "organizational learning," is the distinguishing characteristic of the innovative methods of managing work that were pioneered in Japan and are now diffusing to Western industry (Cole 1989; 1992; 1994;

Rohlen 1992, Nonaka 1991; Nonaka and Takeuchi 1995). Second, there seems to be agreement, and some solid supporting evidence, that innovative work practices are most effective when they are implemented as a "system" of mutually reinforcing practices (Levine and Tyson 1990; Bailey 1993; MacDuffie 1994; Ichniowski and Shaw 1995).

A Model of Work System Innovation

To examine the use by the Japanese transplants and their U.S. suppliers of innovative approaches to managing production work, we constructed a framework or model in which such approaches are seen as a system of work practices. We included individual practices in the model only to the extent that they contribute to organizational learning or improvement. Because our focus is on the management of direct production work, we are interested in practices that contribute to the on-going improvement of manufacturing processes. For a system of work practices to promote manufacturing process improvement, they must not only motivate workers to want to make improvements, but also enable them to develop the necessary know-how and give them the authority to do so (Cole 1994). Table 2 lists the practices that make up our innovative work system model and shows their link to the conditions for manufacturing process improvement. This list was drawn from research on production management in large Japanese manufacturing firms, studies of work organization among Japanese transplants in this U.S. and the burgeoning literature on "organizational transformation."[5] The practices that comprise the model have been grouped into three dimensions according to how they are thought to interact in bringing about the improvement of manufacturing processes:

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[5]For reviews of this literature, see Bailey (1993) and Jenkins (1995).

teamwork, worker involvement and skill development.[6] The variables used to operationalize the model are defined in Table 3 and described in more detail below under the appropriate work system dimension.

[Table 2 about here]

[Table 3 about here]

Teamwork. Organizing workers in teams to carry out the direct work of production motivates workers by encouraging mutual monitoring of performance and by engendering team spirit (Cole 1989). Work teams promote skill development required for manufacturing process improvement by facilitating learning by example, coaching and learning by teaching others. To the extent that such teams have the authority to decide how to carry out their work and to solve problems as they arise, work teams can benefit process improvement by providing multiple feedback channels to ensure speedy response to problems and by affording multiple perspectives for problem-solving. Two variables are included in the model to indicate the use of production worker teams in a given plant: %TEAMS, which is the percentage of production workers who regularly work in teams, and TEAMSAY, which measures the scope of authority given to these teams.

In addition to carrying out the direct work of production in teams, workers can also

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[6]The model assumes that these practices interact with one another as a *system* in bringing about on-going improvement of manufacturing processes. However, we depart from previous studies that have distinguished between practices that govern the way work tasks are carried out on the factory floor and those that reflect plant or firm-level human resource policies. MacDuffie (1995) groups his "bundles" of practices this way, following Osterman (1994), who distinguishes between practices by which the direct work of production or service is organized, on the one hand, and supporting human resource management policies, on the other hand. Many of the studies in the "organizational transformation" literature reviewed by Bailey (1993) use a similar taxonomy. In a test not reported here, we estimated MacDuffie's model of human resource bundles using data from our 1994 survey and the structural equations modeling method we employ here to validate our model. The results fail to support the discriminate validity of MacDuffie's grouping of practices into two "bundles," where one bundle includes practices related to the organization of work on the factory floor and the other consists of a set of supporting human resource policies.

take part in problem-solving groups or "quality circles," where they meet off-line, apart from their regular production duties, to discuss particular problems with the production system and work environment. Participation by workers in such groups promotes manufacturing process improvement by teaching workers to identify problems and their root causes, to work together to devise solutions, and to present those solutions to others within the work group (Cole 1994). To the extent that the ideas generated by these groups are implemented, and that workers are involved in the implementation, problem-solving groups also offer workers a chance to contribute to manufacturing process improvement directly (Cole 1989; Lincoln and Kalleberg 1990). The variable %QCS is included to measure the percentage of production workers actively involved in such off-line problem-solving groups. In addition to these two types of team structures, efforts to minimize status distinctions between workers and managers (measured in the model by the STATUS variable) and pay systems that provide incentives for group performance (measured by the GROUPPAY variable) motivate workers to contribute to organizational performance by giving the sense that they are part of the same "team" as managers and rewarding them for acting in the collective interest.

Worker Involvement. The second dimension consists of practices that involve front-line production workers in job design, quality control and other functions that, in the U.S. at least, were traditionally the purview of managers and other professional employees. A key step toward involving production workers is for managers to provide them with information about the performance of the products they produce as well as of the company by which they are employed. The INFOSHARE variable is included in the model to measures the extent of such information sharing in a plant. Where production workers do not have broad discretion over how to do their jobs, and where the variety of tasks they do is limited, there is less opportunity for workers to develop the kinds of knowledge and insights about the production process that would enable them to devise suggestions for improving the production system. If workers are forced to carry out job protocols dictated by others removed from the production floor, they have little incentive to learn as part of their work. Relegated to performing highly-specified job tasks, workers have cause to resist taking part in innovation, since they could well be displaced from their jobs by the productivity improvements that may result. In contrast, where workers have more control over their work and are able to develop deep knowledge about the production system in the process, they have more to contribute to process improvement and are more likely to want to do so. The variable CONTROLMETH is included as a measure of the extent to which production workers have a say in the design and updating of work methods. The JOBCLASS variable indicates the number of job classifications for production workers at a plant. It is reverse coded, so that a higher value indicates lower functional specialization (or higher functional integration) of production jobs.

Another dimension of worker involvement that can enhance organizational innovation is the practice of giving workers responsibility for monitoring the quality of products they produce. This promotes process improvement because front line workers are in many respects best-positioned to see problems with the production system as they arise and to figure out how best to solve them. Centralizing responsibility for quality tasks can be detrimental, since it excludes those who are closest to the point of production where the information relevant to quality control is in many respects richest (Cole 1989; 1992; 1994). Hence, shop floor quality improvement will be limited to the extent that such tasks are the purview of managers, engineers and quality control specialists as opposed to production workers. Two measures are included in the model to gauge the extent of production worker involvement in quality control. %SPC is the percentage of a plant's production workers who regularly use statistical process control in their work.

CONTROLQUAL measures the extent to which production workers have responsibility for quality control at different phases of the production process: supplied components, work in progress, and finished products. Suggestion systems, in which workers can recommend ways to improve operations or working conditions, are another way that production workers can take part in quality control and improvement. Cole (1989, 1994) argues that allowing workers to exercise initiative in solving problems enhances their self-esteem by giving them the sense that their ideas are valued. As a result, they are more likely to feel that they are part of the larger organization and to be committed to its purposes. The variable IDEARATE is included in the model to measure the number of suggestions for improvement per employee that were offered by plant employees in the year preceding the survey.

Skill Development. Skill development can take place both through formal training outside of regular job activities and through structured learning on the job. In the latter, learning is embedded in the everyday work of production and is aimed at developing knowledge specific to the organization. In the plants of large manufacturers in Japan, practices such as rotating workers among jobs and departments and promoting supervisors and managers from the ranks of production workers foster the development of a broad base of knowledge specific to the organization and its operations (Koike 1994). With a prodigious supply of home-grown talent and strong commitment to the shared goals that these practices engender, the organization has both the means and the impetus not only for bringing about incremental improvements to production processes but also to make the transition to entirely new forms of technology. The proprietary nature of these structures for learning makes them difficult to duplicate. Hence, the competitive advantage they help to create is likely to endure. Three variables are included in the model to indicate the extent of formal training: %WRKTRAIND, which is the percentage of a plant's production workers who received off-the-job training in the past twelve months; %MGRTRAIND, the percentage of production supervisors and managers trained in the past year; and TRAINSCOPE, which measures the range of training topics offered to production workers and managers. Structures for informal skill development are measured by JOBROTA, which indicates the extent to which production workers are rotated within and across work groups and departments, and PROMOTEIN, which is the percentage of the plant's supervisors and managers who were promoted from a production worker job.

To test the hypothesized relation of the practices entailed by the three work system dimensions to manufacturing process improvement, we included in the model measures of the scale and scope of quality-related manufacturing process improvement activity in the plant. MPIRATE indicates the number of times in the past 12 months that changes were made to the manufacturing process for the plant's largest-selling product. The MPISCOPE variable measures the extent to which such changes were motivated by efforts to enhance product quality, eliminate waste or improve product flow, rather than merely by changes in product specifications or product demand.

Validating the Model using the Survey Data

We estimated our model of an innovative production work system using our survey data and a structural equations modeling technique that makes it possible to test hypotheses concerning not only which practices are used in conjunction with one another but how they are interrelated (Kim and Miller 1978; Anderson and Gerbing 1988). In this method, which is also known "confirmatory factor analysis," the model is specified as a series of equations in which the observed variables (which in this case measure the particular work practices) are assumed to be caused by the latent variables (which in this case represent the work system dimensions) (Kim and Miller 1978; Anderson and Gerbing

1988). The equations are estimated simultaneously and the covariances among the variables are decomposed to describe the relationship between the unobserved and observed variables as well as among the unobserved variables themselves. This method has several advantages over exploratory factor analysis and other techniques used in previous research to validate models of organizational innovation. For one, it allows statistical tests to be performed to determine if the sample data are consistent with the imposed constraints, or, in other words, whether the data *confirm* the conceptually generated model. As such, the method provides a rigorous test of the conceptual model (Long 1983a, 1983b). A fuller exposition of the method is given elsewhere by the authors (Jenkins 1995; Jenkins and Florida 1995).

The model was estimated separately using four subsamples of our data: 1) all Japanese transplants; 2) Japanese transplants not involved in the supply of products for automobile production; 3) transplant automobile parts suppliers; and 4) U.S.-owned suppliers to the Japanese transplant automotive assemblers. The transplant automotive suppliers are split out not only to allow comparison with the U.S. automotive suppliers but to determine if they differ markedly in their approach to managing production work from transplants not involved in the production of automobiles, given that the literature on the transplants has been so heavily influenced by studies of the automobile sector.

Table 4 shows the means of the variables measuring the use of particular practices for each of the four subsamples of interest. Differences of means tests indicate varying patterns in the use of certain practices not only between Japanese-affiliated and U.S.-owned plants, but between those plants in our sample that are involved in the production of automobile components compared to those that are not. For example, workers teams are given greater authority in U.S.-owned automotive supplier plants than in the Japanese-affiliated plants in our sample, whether or not they are involved in auto parts production.

This is consistent with the finding, mentioned earlier in the comparison of our survey results with those of Osterman, that U.S. manufacturers are more likely to use "self-directed" worker teams, which are more of an American invention though they reflects Japanese ideas. Plants that are involved in the supply of components for automobile production, whether they are affiliated with Japanese or U.S. firms, are more likely to adopt innovative practices such as teams and suggestion systems. Automotive supplier plants, whether transplant or U.S.-owned, are also more likely to give production workers greater responsibility for quality control and to offer extensive training to production workers and managers. Hence it seems that some artifact of the automotive sector, rather than national affiliation of the firm, is responsible for a greater propensity to adopt these innovations.

[Table 4 about here]

The results of the confirmatory factor analysis show a statistically significant association between most of the variables representing innovative work practices and the work system dimensions with which they were hypothesized to be associated. This indicates that, in general, plants in the four samples are using these innovative practices in conjunction with one another as expected. A few variables failed to exhibit the expected relationship with the latent work system dimensions. For example, the STATUS variable, which is reversed coded to measure the lack of status differentiation in a plant, is significantly associated with teamwork only for the U.S.-owned sample of plants. Similarly, contrary to the practice of large automotive and electronics manufacturers in Japan, the transplants do not seem to use consolidation of production worker job classifications (JOBCLASS) as a means of expanding worker involvement or authority, whereas among the U.S.-owned suppliers examined here, such functional integration of production jobs is associated with other efforts to promote worker involvement. In these respects, the U.S. automotive suppliers surveyed here seem in general to be more "Japanese" than the Japanese-affiliated plants. For neither the transplants nor the U.S. suppliers do job rotation (JOBROTA) or promotion of managers from within (PROMOTEIN) seem to play a role in skill enhancement, despite the fact that these practices have been recognized as means of skill development in the plants of large manufacturers in Japan (Koike 1994).

Consistent with accepted practice in structural equations modeling (Long 1983b), we deleted from the model those variables that showed no statistically significant loading on the latent work system dimensions to which they were assigned.[7] The elements of the revised model are illustrated in Figure 1. Note that in addition to removing the variables for which no significant effect is evident, we renamed the "Skill Development" work system dimension to "Training," since only training-related variables remain under that dimension of the model.

[Figure 1 about here]

Figure 2 shows the covariances among the (latent) work system dimensions for the Japanese transplants. All such covariances are statistically significant. The relatively strong covariances among the "Worker Involvement" and the "Teamwork" and "Training" dimensions suggest that where production workers are involved in job design and quality control, it is deemed appropriate to organize workers into teams and provide them with a broad range of off-the-job training. A similar pattern of covariances among the work system dimensions is evident for the U.S.-owned supplier subsample.

[Figure 2 about here]

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[7]Statistical tests not reported here showed no "cross-loading" among of any of these non-significant variables on any other latent dimension in the model.

The three dimensions of the work system model are also significantly associated with the intensity of manufacturing process improvement activity in the manufacturing plants in our survey sample. By far the strongest link to process improvement activity is through the "Worker Involvement" dimension. This suggests that giving front-line workers responsibility for deciding how to carry out their jobs is an effective way to foster continuous improvement and to achieving gains in organizational learning are likely to result from such activity.

In the revised model, we have identified a set of innovative work practices that are positively related to the level of manufacturing process improvement activity in our sample of plants and are used in conjunction with one another as a work system by both Japanese transplants across a wide range of industries and U.S.-owned suppliers to the transplant automotive assemblers. The practices that comprise the three dimensions of the model reflect a blend of Japanese and American influences. The fact that the same model of work system innovation is evident among the U.S.-owned supplier plants suggests that this approach is not unique to Japanese manufacturers.

THE PATTERN OF WORK SYSTEM INNOVATION AMONG THE TRANSPLANTS

To examine the pattern of work system innovation among the U.S.-based Japanese transplants and their U.S.-owned suppliers, we used cluster analysis to group the plants that responded to our survey according to their use of the production work practices that were found to be interrelated by the structural equations analysis of the last section. We then examined the factors associated with the adoption of the different work system types or "regimes" identified.

Clustering Plants by Work System Regimes

We hypothesize that the plants in our sample will fall along a continuum of approaches to managing production worker ranging from what we term "Taylorist" to "Innovative." Table 5 summarizes the sorts of contrasts we expect to observe between plants that take a Taylorist approach to managing production worker and those where the work system can be classified as Innovative.[8] In general, we expect the Taylorist plants to be characterized by greater functional specialization, centralization of control over job design and quality control and lack of emphasis on training for production workers in particular. Innovative plants will exhibit greater degrees of teamwork, worker involvement, training and other practices shown by the structural equations analysis of the last section to be associated with higher levels of manufacturing process improvement activity in the plants in our survey sample.

[Table 5 about here]

Five clustering techniques were used to group our sample of plants according to their use of the innovative work system practices validated in the last section. Four of the five methods produced similar two- and three-cluster solutions.[9] Comparing the results of

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[8]"Taylorist" is an appropriate antipode to "Innovative" in the context of this study from the perspective of those, ourselves among them, who see Taylorist approaches to managing work as inhibiting manufacturing process improvement and other forms of organizational learning while Innovative work systems are seen to enhance it. A compelling statement of this view is given by Cole (1994) in a discussion of the implications for organization learning of two contrasting paradigms of work organization, one of which he labels "Taylorist" and the other of which he calls "the quality improvement paradigm that has emerged over the past few decades in Japan and is now diffusing to Western industry." The latter paradigm is the one we see as governing the design of the "Innovative" work systems observed here. Cole argues that the inspection-oriented approach of Taylorism to quality control discourages continuous improvement in a number of ways.

[9]All clustering methods produce solutions (Everitt 1980; Aldenderfer and Blashfield 1984). Only the Single Linkage method produced widely divergent results. This method grouped most of the observations in a single cluster, with the remaining clusters consisting of only one or two observations. This "chaining" effect is characteristic of the Single Linkage method and provides an indication of how closely grouped the data are along the dimensions measured. For this reason, we decided that the Single Linkage method is not appropriate for use in this analysis.

these four methods, we chose Ward's method as producing the most useful cluster pattern for our purposes here.[10] The means of the work practice variable for the two- and three-cluster solutions produced by Ward's method are shown in Tables 6 and 7 respectively. Note that all variables have been standardized by transformation to z-scores to facilitate comparison among them.

[Table 6 about here]

[Table 7 about here]

In the two cluster solution (Table 6), one cluster consists of plants that score below the sample mean on all measures, while the other cluster consists of plants that score above the sample mean. Supporting our hypothesis, the plants in the first cluster exhibit an approach to managing production work that can be characterized as Taylorist, while those in the second cluster exhibit the functional integration, worker involvement, emphasis on training that are characteristic of the Innovative work system model.

In the three-cluster solution produced by Ward's method (Table 7), the plants in the Taylorist cluster have been split into two clusters, one in which the plants score below the mean on all practices, and the other in which the plants score below the mean on most practices, except those related to training. Plants in this latter group tend to place a great emphasis on providing formal off-the-job training for workers and mangers, but have not adopted teams, worker involvement and other practices related to the organization of work on the shop floor. We refer to the approach to managing production work exhibited by this second cluster of plants as "Mixed," since it may reflect two or more strategies. On one hand, it could represent a strategy that sees deficiencies in the skills of individual workers,

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[10]Ward's method yielded cluster solutions with the highest sum of eigenvalues based on canonical discriminant variables. This means that, of the methods tried here, Ward's method produced the most statistically distinct clusters, although such a test should not be seen as formally validating the resulting cluster structure.

rather than the system by which production work is managed, as the chief impediment to problem-solving and performance improvement. As such, this strategy seeks to remedy these deficiencies by providing extensive off-the-job training to individual workers while managing work on the shop floor using traditional Taylorist methods. One the other hand, it might be seen as a effort to use training to "transition" workers from a Taylorist to an innovative work system regime. Evidence that both strategies are present among the Mixed group of plants is given below.

Plants in these three clusters can be seen as representing a continuum of "innovativeness" in the approach to managing production work that stretches from the low end with the Taylorist plants to the high end with the Innovative plants. Table 8 summarizes statistical analyses of the correlation between the three work system types and measures of innovative activity gleaned from the survey.[11] The structural equations modeling of the previous section showed a connection between practices entailed in an innovative work system and efforts to bring about on-going improvement of manufacturing processes within the plant. As is indicated in Table 8, plants in the Innovative work system group exhibit higher levels of manufacturing process improvement activity than do plants whose approach to production management has been classified as Mixed or Tayorist. When compared to Taylorist plants especially, Innovative plants are also more likely to engage in other sorts of innovative activity, including concurrent engineering of products, environmentally-conscious or "green" product design and benchmarking the practices of other plants. There is also a strong association between the use of innovative production work practices and formal, plant-wide programs for systematically improving

[11]Details on these analyses are given by Jenkins (1995).

product quality, such as total quality management (TQM).[12] In addition, innovative work systems are also associated with "lean" management, as measured by the ratio of managers to workers, and, among plants in our sample that supply parts for use in automobile production in particular, with "leaner" levels of inventory for raw materials, work in process and final goods.[13]

[Table 8 about here]

Table 9 summarizes the characteristics of the plants in the three clusters.[14] Plants that have adopted Innovative production work systems tend to use production technology of greater capital intensity and to hire more educated workers for production work than do plants that take a Taylorist approach to managing production work. In analyses not reported here in which we controlled for the effect of other factors such as plant size and age of plant, capital intensity was found still to have a strong association with the adoption of an Innovative work system. This makes sense given that the high fixed costs of a capital intensive production system put a premium on ensuring high capacity utilization. Capital intensity therefore creates an incentive to manage production work in ways that facilitate trouble-shooting and continuous improvement of the production system. In short, advanced plant and equipment is likely to require advanced organizational practices for their optimal utilization and performance. The use of Innovative work methods that give workers greater authority for job design and quality control seem to require in turn a more

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[12]Interestingly, the connection between work system innovation and total quality management is just as strong for the Japanese-affiliated plants in our sample as for the U.S.-owned establishments.

[13]The finding regarding inventories applies to both Japanese-affiliated and U.S.-owned automobile parts suppliers.

[14]These findings are based on statistical analysis of the correlates of the three plant clusters with other data collected through the survey. The details of this analysis are given in Jenkins (1995).

highly educated workforce. Perhaps related to this is the fact that Innovative plants are not only more likely than Taylorist plants to make a pledge of job security to workers but also tend to make good on such pledges with active efforts to avoid layoffs. This provides support for the view that efforts to transform the management of work such that workers are more involved in and responsible for the on-going improvement of organizational processes need to be accompanied by assurances that worker's jobs will not be jeopardized as a result of their contribution to productivity improvement and by active steps to ensure their job security. Innovative plants are also more likely to have cooperative relationships with their customers and suppliers than Taylorist plants, whose customer and supplier relations can be characterized generally as "arm's length."[15]

[Table 9 about here]

The "Mixed" plants tend to be larger and older plants that pay relatively high wages and are more likely to be unionized. These plants are more likely to have experienced recent restructuring or downsizing as well as greater turnover of production workers. The instability of plants in this cluster may have provided an impetus for some of them to adopt a Mixed work system strategy, with its heavy emphasis on training. Thus, the large investment by some of these plants in off-the-job training for production workers seems to reflect an attempt to reassure workers (and their unions) that management has their interests and well-being in mind during a period of turbulence and uncertainty for the plant. By the same token, these efforts may also represent an effort by management to correct through training problems perceived to be contributing to the current instability at the plant. There is evidence from our survey to suggest that both strategies are evident among plants

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[15]The connection between an Innovative approach to managing production work within the factory and cooperative relations with external customers and suppliers is explored by the authors in greater depth elsewhere (Jenkins 1995, Jenkins and Florida 1995).

in the "Mixed" cluster.[16]

Pattern of Innovation among the Japanese Transplants

Table 10 shows the distribution of the three work system types or "regimes" among the U.S.-based Japanese transplants in 1994. More than 40 percent of the transplants had adopted approaches to managing production work that can be classified as Innovative. However, nearly 45 percent of transplants were found to use Taylorist work practices. These transplants made little, if any, use of innovative practices. Approximately 15 percent of transplants followed a "mixed" approach, characterized by heavy investment in training, but with a tendency to use Taylorist approaches to manage the work of production on the factory floor.

[Table 10 about here]

A key finding, then, of this first survey of the work practices of the population of Japanese transplants in the U.S. is that there is considerable variation in the pattern of adoption of work system innovations. While a sizeable proportion of the transplants have adopted methods of managing production work that are conducive to manufacturing

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[16]In our survey, respondents were asked to rate a list of factors by the extent to which each has been an obstacle to recent efforts to improve productivity, quality and costs at the plant. Of all the factors rated, only two have statistically significant relationships with a particular work system regime. Plants in the Mixed cluster were significantly more likely to cite "inadequate skills of production workers" and "programs are still new" as obstacles, while the Innovative plants were significantly more likely to see the newness of programs as an impediment. The responses from plants in the Mixed cluster indicate that the Mixed work system group actually represents a mix of strategies. Among plants that see the "inadequate skills of production workers" as an impediment to improvement efforts, a Mixed strategy makes sense as an attempt to remedy the perceived problem—skill deficiencies—by providing off-the-job training for these workers. Plants that see the individual worker as the source of the problem are unlikely to seek to change the system by which workers are managed. Among Mixed plants indicating that the "programs are still new," the approach of such plants can be seen as an attempt to use the training of workers and other employees as a means of "transitioning" the plant from a Taylorist to an Innovative system of production management. Hence, it is likely that a mix of strategies are at work among the plants in the Mixed cluster.

process improvement and that mirror in general respects practices associated with large automobile and electronics firms in Japan, others rely on Taylorist methods characteristic of traditional heavy industry in the U.S.

In exploring further the variation in the pattern of adoption of work system innovations among the Japanese transplants, we find that there are key differences by industry sector. (See Table 10 again.) A strong finding that holds up under further analysis is that Japanese transplants involved in the supply of parts and other products for use in automobile production were significantly more likely than plants not involved in automobile production to take an innovative approach to managing production work and significantly less likely to follow the Taylorist model.

Japanese Transplants Compared with U.S. Suppliers

Earlier we compared data from our survey of the transplants and a survey by Osterman of a representative sample of U.S. manufacturing establishments to show that the transplants were on the whole more likely to use certain innovative methods for managing production work than were manufacturing plants in the U.S. generally.[17] The distribution of the three work system regimes among transplant and U.S.-owned automotive parts supplier plants is compared in Table 10.[18] These data show that, among plants in automotive parts supply, U.S.-owned plants are just as innovative in their approach to managing production work as are the transplants. This is perhaps not so surprising in light of evidence from studies of the efforts of Japanese transplant automotive

[17]It is important to point out again that Osterman's survey (1992) preceded ours (1994) by two years and that Osterman's sample was limited to establishments of 50 or more employees, whereas our sample had no size limit.

[18]The "Other Foreign" plants listed in the table are the 14 plants in our sample that were affiliated with foreign firms other than Japanese. The majority of these were German firms.

assemblers to identify and cultivate suppliers that are innovative.[19] Of course, the U.S.-owned supplier plants in our sample were also found to supply U.S.-owned automotive assemblers in addition to the transplants. Only 16 percent of the U.S.-owned automotive supplier plants supplied a majority of their output to Japanese-affiliated customers. Therefore, the fact that these plants supply Japanese customers is probably not the only or even the main reason that they tend to be so innovative in their approach to managing production work. These findings, combined with evidence presented earlier, suggest that work system innovation is more prevalent among plants in the automotive sector generally, whether or not they are affiliated with or heavily dependent upon Japanese companies.

CONCLUSION

Using data from the first survey of the production management of the population of Japanese transplants in the U.S., we succeeded in identifying a set of work practices that are used in conjunction with one another by both Japanese transplants across a wide range of industries and U.S.-owned suppliers to the transplant automobile assemblers. These practices are used together as part of a production work system consisting of three dimensions—teamwork, worker involvement and training—that are positively associated with the level of manufacturing process improvement activity in the manufacturing plants in our survey sample. The practices that comprise the three dimensions of this work system model reflect of blend of Japanese and American influences. This supports the findings of previous research that the approach of the Japanese transplants to managing production work reflects a transfer of some practices from Japan and a borrowing of other

[19]See for example the chapter in this volume by MacDuffie and Helper.

practices of American origin as part of a process of adaptation to the American economic environment. The fact that the same general model of work system innovation is evident among the U.S.-owned supplier plants as among Japanese-affiliated plants suggests that this approach is not unique to Japanese manufacturers and may well be prevalent among manufacturers in the U.S. not related in any way to the transplants.

There is considerable variation among the U.S.-based Japanese transplants in their approach to managing production work. While a sizeable proportion of the transplants have adopted Innovative approaches to managing production work that are conducive to manufacturing process improvement and that mirror in general respects the stylized model of work organization associated with large automobile and electronics firms in Japan, others have adopted a Taylorist approach characteristic of heavy industry in the United States. Still others follow a "mixed" approach, characterized by heavy investment in off-the-job training, but with a tendency to use Taylorist methods of managing production work on the factory floor. At least two strategies are evident among the plants in the Mixed work system group: those that see the skill deficiencies of production workers, rather than the system by which production work is managed, as impediments to performance improvement, and those that are attempting to use training as a means of "transitioning" workers from a traditional Taylorist to an Innovative system of production management.

The adoption of innovative work systems is significantly more prevalent among transplants involved in the supply of parts and other products for use in automobile production than among those outside of the automotive sector. This finding is important because the literature on work organization among the transplants has been heavily influenced by studies of the automotive sector. The U.S.-owned automotive supplier plants we surveyed are found in general to be equally as innovative in their approach to managing production work as the Japanese transplant automotive suppliers. Hence, we find evidence of a greater propensity to adopt work system innovations among plants in the automotive sector that is independent of affiliation with or dependence upon Japanese companies.

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Table 1 Adoption of Innovative Work Practices: U.S.-based Japanese Transplants and U.S. Manufacturing Plants Generally

Practice	Japanese Transplants[1]	Manufacturing Plants in the U.S.[2]
Quality Circles: % of Plants	77.5	50.7
Quality Circles: % Participation	41.7	34.1
Self-directed Teams: % of Plants	43.7	50.0
Self-directed Teams: % Participation	31.5	34.9
Job Rotation: % of Plants	63.1	52.0
Job Rotation: % Participation	NA	33.9
Statistical Process Control: % of Plants	70.1	52.3
Statistical Process Control: % Participat.	30.8	28.6
Off-the-job Training for Production Workers: % of Plants	79.2	70.9
Off-the-job Training for Production Workers: % Participation	39.7	27.8
No layoff pledge to production workers?	52.1	40.2
Group incentive compensation (e.g. gain sharing) for production workers: % of Plants	13.4	12.4
Pay for skills for production workers: % of Plants	45.6	36.9
Profit sharing for production workers: % of Plants	50.3	42.1
TQM: % of Plants	62.1	47.6
TQM: % Participation	40.1	34.9

[1] Data for Japanese-affiliated manufacturing plants in the U.S. are from a 1994 survey by Richard Florida and Davis Jenkins of Carnegie Mellon University.
[2] Data for U.S. manufacturing plants are from a 1992 survey by Paul Osterman and published in Osterman (1994). Only data for plants in industries comparable to those in the Florida and Jenkins sample are reported here.
Observations have been weighted to produce estimates for the entire population of plants sampled in each case.
"% of Plants" indicates the percentage of plants in each sample that use the given practice.
"% Participation" indicates the percentage of production workers in a plant who participate in the given practice.

Table 2 Hypothesized Practices of an Innovative Work System and their Link to the Conditions for Manufacturing Process Improvement

Dimension Element	Motivates Initiative/Commitment	Develops Skill/Knowledge	Enhances Authority/ Opportunity
Teamwork			
Worker Teams	✓	✓	✓
Problem-Solving Groups	✓	✓	?
Compensation Tied to Group Performance	✓		
Low Status Differentiation	✓		
Worker Empowerment			
Product/Business Information Shared with Workers	✓	✓	
Low Functional Specialization	✓	✓	✓
Workers Define Work Methods	✓	✓	✓
Decentralization of Quality-Related Tasks	✓	✓	✓
Suggestion System	✓	✓	?
Skill Development			
Training of Production Workers	✓	✓	
Promotion from Within	✓	✓	✓
Job Rotation	✓	✓	✓
Training of Supervisors and Managers	✓	✓	

Table 3 Definitions of Work System Model Variables

Dimension VARIABLE	Definition
Teamwork	
%TEAMS	= percentage of production workers who regularly work in teams
TEAMSAY	0 = work teams have little authority,...5 = work teams have extensive authority
%QCS	= percentage of production workers currently involved in off-line problem-solving groups or quality circles
GROUPPAY	0 = pay tied to job classification and/or seniority,...4 = pay based on group performance and skills learned
STATUS	0 = extensive status differentiation,...5 = little status differentiation
Worker Involvement	
INFOSHARE	0 = management shares little information with production workers;... 5 = extensive information sharing
JOBCLASS	0 = 20 ore more formal job titles for production workers,...4 = 1 job title for production workers
CONTROLMETH	0 = production workers have little say in the design of work methods;...3 = production workers have extensive say in design of work methods
%SPC	= percentage of workers who regularly use statistical process control (SPC) in their work
CONTROLQUAL	0 = productions workers have little responsibility for quality control,...3 = workers have extensive responsibility for quality control
IDEARATE	= number of suggestions per plant employee in 1993.
Skill Development	
%WKRTRAIND	= percentage of production workers who received off-the-job training in the past 12 months
TRAINSCOPE	0 = no or limited range of training for production workers;...5 = extensive range of training provided to production workers
JOBROTA	0 = no job rotation of production workers,...3 = extensive rotation
PROMOTEIN	= percentage of supervisors and managers who were promoted from a production worker job
%MGRTRAIND	= percentage of supervisors and managers who received off-the-job training in the past 12 months
Manufacturing Process Improvement	
MPIRATE	= number of times in past 12 months that changes were made to the manufacturing process for the plant's largest selling product
MPISCOPE	0 = limited range of reasons for quality-oriented manufacturing process improvements,...3 = extensive range of reasons

Table 4 Innovative Work System Model: Means (Standard Deviations) of Indicator Variables

Dimension and Indicators	Japanese Transplants	Japanese Transplants Not in Autos	Japanese Transplants Auto Suppliers	U.S.-owned Auto Suppliers
Teamwork				
%TEAMS	45.8 (42.6)	43.2* (42.8)	50.3* (41.9)	46.0 (39.6)
TEAMSAY	2.0* (1.7)	1.8 (1.7)	2.2 (1.6)	2.6* (1.7)
%QCS	41.8 (39.1)	41.8 (40.5)	41.8 (36.5)	38.0 (35.4)
GROUPPAY	1.2 (1.0)	1.2 (1.0)	1.2 (0.9)	1.2 (0.9)
STATUS	3.5* (1.1)	3.3* (1.0)	3.9* (1.0)	2.8* (0.9)
Worker Involvement				
INFOSHARE	3.5 (1.4)	3.5 (1.4)	3.4 (1.4)	3.7 (1.3)
JOBCLASS	2.0 (1.2)	2.0 (1.2)	2.0* (1.2)	1.5* (1.2)
CONTROLMETH	-0.1 (1.0)	-0.03 (1.1)	-0.1 (1.0)	0.1 (0.9)
%SPC	30.8* (36.4)	26.7* (34.7)	38.3* (38.2)	45.7* (34.8)
CONTROLQUAL	0.0 (1.0)	-0.1* (1.1)	0.2* (0.8)	0.0 (1.0)
IDEARATE	1.2 (1.2)	1.1* (1.2)	1.4* (1.2)	1.3 (1.2)
Skill Development				
%WKRTRAIND	39.6 (41.4)	34.3* (40.3)	49.3* (41.7)	50.1 (40.9)
TRAINSCOPE	2.9 (1.7)	2.5* (1.7)	3.6* (1.4)	3.8 (1.3)
JOBROTA	1.8 (1.0)	1.8 (1.1)	1.8 (1.0)	1.8 (1.0)
PROMOTEIN	44.5 (35.0)	41.3* (34.6)	50.6* (35.0)	54.6 (30.5)
%MGRTRAIND	52.1 (40.3)	44.4* (40.3)	66.6* (36.6)	65.8 (38.0)
Manufacturing Process Improvement				
MPIRATE	11.5* (25.0)	10.6 (23.8)	13.1 (26.9)	20.0* (33.2)
MPISCOPE	1.5* (1.3)	1.5 (1.3)	1.6 (1.3)	2.0* (1.2)
N	390	250	140	127

*Difference of means statistically significant at $p<0.01$ based on t-tests.

Figure 1 Confirmatory Factor Analysis of an Innovative Production Work System (Revised Measurement Model)

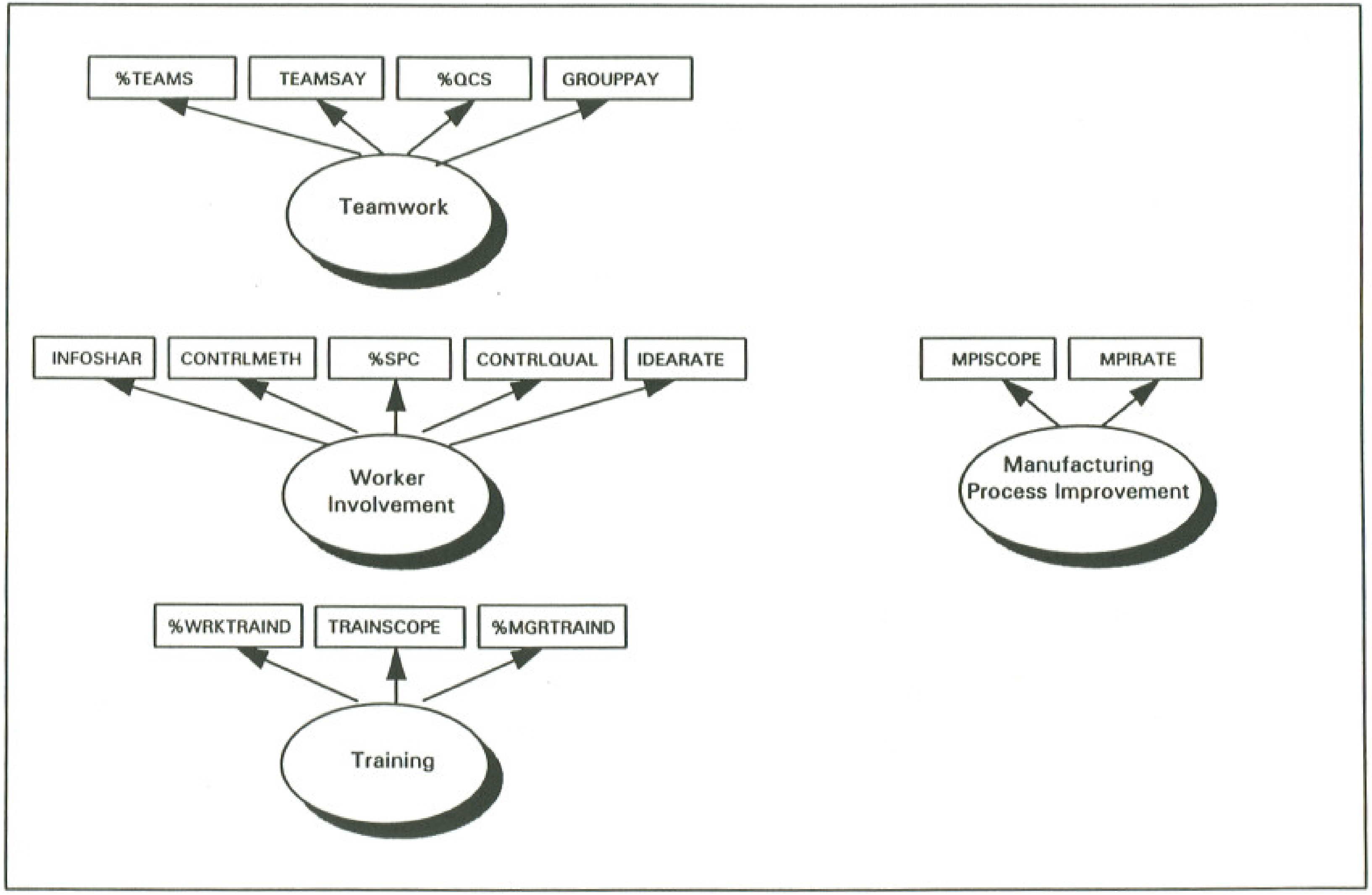
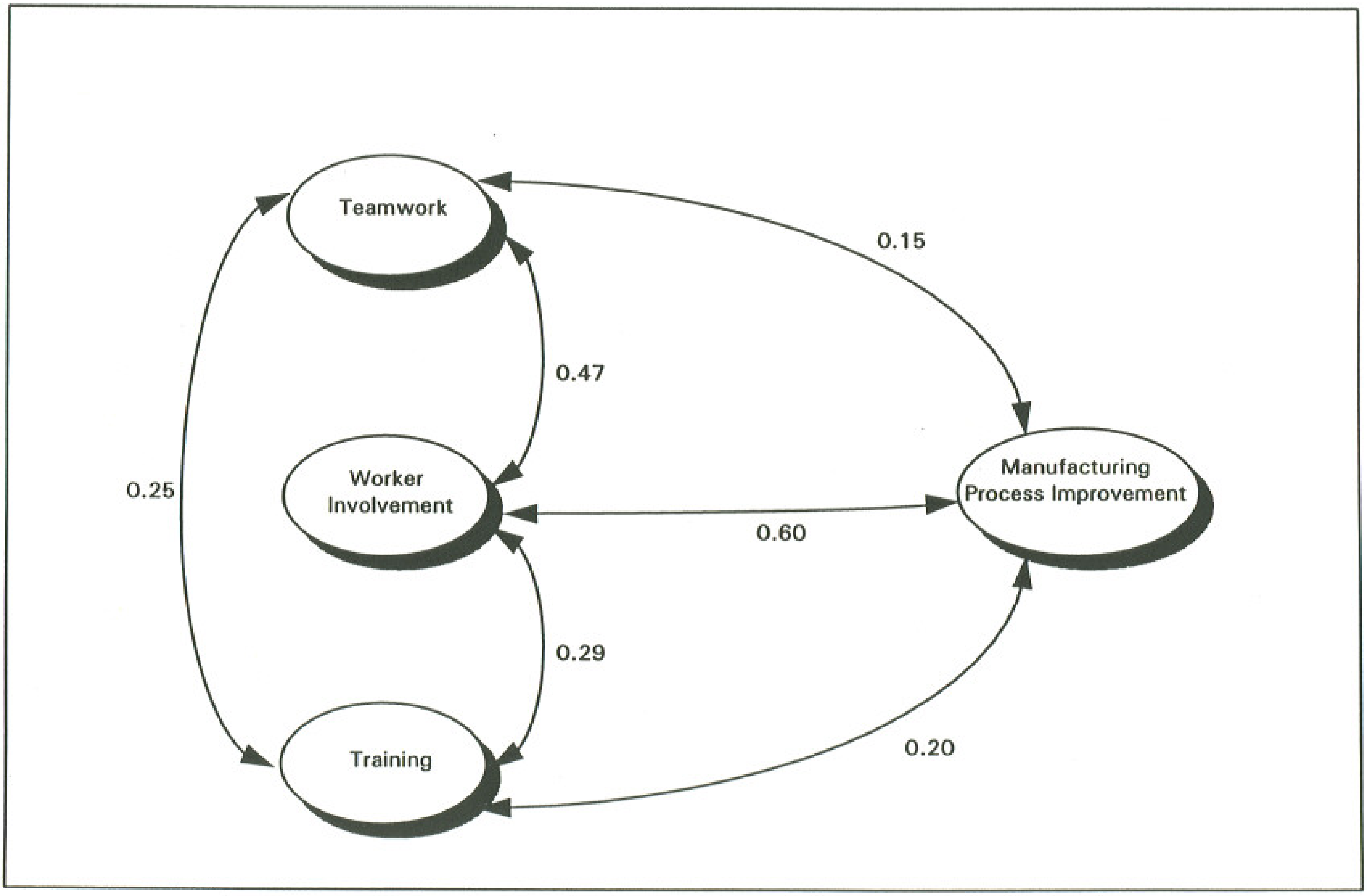


Figure 2 Covariance Structure Model of an Innovative Production Work System
Covariances Among Latent Work System Dimensions
U.S.-based Japanese Transplants



Note: All covariances are statistically significant at $p < 0.01$.

Table 5 Hypothesized Contrasts between Taylorist and Innovative Work Systems

	Taylorist	Innovative
Teamwork		
Production management	Closely supervised, narrowly defined tasks	Worker-led teams
Quality circles	No	Yes
Pay	Tied to job classification and/or seniority	Based on group performance
Worker Involvement		
Information sharing with workers	Limited	Extensive
Control of job design	Industrial engineers and supervisors	Production workers
Responsibility for quality control	Quality specialists	Production workers
Suggestion systems	No	Yes
Training		
Training of production workers	Limited	Extensive
Training of managers	Moderate	Extensive

Table 6 **Means of Work System Variables by Plant Cluster**
Two-Cluster Solution by Ward's Method for Pooled Sample of Plants

Dimension and Variable	Cluster 1 (Taylorist)	Cluster 2 (Innovative)
Teamwork		
%TEAMS	-0.52	0.64
TEAMSAY	-0.57	0.71
%QCS	-0.30	0.38
GROUPPAY	-0.21	0.26
Worker Empowerment		
INFOSHARE	-0.25	0.31
CONTROLMETH	-0.36	0.45
%SPC	-0.34	0.41
CONTROLQUAL	-0.31	0.39
IDEARATE	-0.18	0.22
Skill Development		
%WKRTRAIND	-0.25	0.31
TRAINSCOPE	-0.38	0.47
%MGRTRAIND	-0.25	0.31
N	286	231

Note: All variables have been standardized using the z-score transformation.

Table 7 Means of Work System Variables by Plant Cluster
Three-Cluster Solution by Ward's Method for Pooled Sample of Plants

Dimension and Variable	Cluster 1 (Taylorist)	Cluster 2 (Mixed)	Cluster 3 (Innovative)
Teamwork			
%TEAMS	-0.37	-0.93	0.64
TEAMSAY	-0.47	-0.87	0.71
%QCS	-0.32	-0.27	0.38
GROUPPAY	-0.23	-0.15	0.26
Worker Empowerment			
INFOSHARE	-0.27	-0.18	0.31
CONTROLMETH	-0.48	-0.05	0.45
%SPC	-0.42	-0.12	0.41
CONTROLQUAL	-0.60	-0.13	0.39
IDEARATE	-0.23	-0.01	0.22
Skill Development			
%WKRTRAIND	-0.64	0.84	0.31
TRAINSCOPE	-0.61	0.25	0.47
%MGRTRAIND	-0.62	0.78	0.31
N	210	76	231

Note: All variables have been standardized using the z-score transformation.

Table 8 Measures of Innovative Activity by Work System Type

Measure of Innovative Activity	Work System Type Taylorist (Cluster 1)	 Mixed (Cluster 2)	 Innovative (Cluster 3)
Manufacturing Process Improvement Activity	Low	Moderate	High
Quality-Oriented Product Design Activity	Limited	ns	Extensive
"Green" Product Design	No	ns	Yes
Concurrent Engineering	Limited	ns	Extensive
Benchmarking of other Plants	No	ns	Yes
TQM Program	No	Yes	Yes
Ratio of Managers to Workers	High	ns	Low
Inventory Levels	High (among Auto Suppliers especially)	Moderate (among Auto Suppliers)	Low (among Auto Suppliers especially)

"ns" indicates that there is no statistically significant relation between the given characteristic and work system type at the $p < .01$ level.

Table 9 Typical Plant Characteristics by Work System Type

Plant Characteristic	Work System Type: Taylorist (Cluster 1)	Mixed (Cluster 2)	Innovative (Cluster 3)
Employment Size	Small	Large	Mid-sized
Brownfield (vs. Greenfield)	Yes (U.S. plants)	ns	No (U.S. plants)
Capital Intensity	Low	ns	High
Wages	Low	High	Mid-range
Union	No	Yes	ns
% Workers Who Are H.S. Grads	Lower	ns	Higher
Hiring Criteria: Production Workers	Experience in Similar Job	ns	Team Work, Problem-Solving Skills, Technical Training
No Layoff Pledge to Workers	No	ns	Yes
Active Efforts to Avoid Layoffs	Limited	Extensive	Extensive
Recent Down-sizing?	ns	Yes	ns
Turnover Rate	ns	High	ns
Obstacles to Performance Improvement	ns	"Inadequate skills of prod. workers" "Programs still new"	"Programs still new"
Relations w/Customers and Suppliers	Arm's length	ns	Cooperative
Place in Supply Chain	Finished Goods Producer	ns	Components Supplier
EDI with Customers and Suppliers	No	ns	Yes

"ns" indicates that there is no statistically significant relation between the given characteristic and work system type at the $p < .01$ level.

Table 10 **Adoption of Work System Regimes among Manufacturing Plants by Ownership and Industry Sector**

	Percentage of Plants by Work System Regime		
	Taylorist	Mixed	Innovative
Japanese Transplants	44.7	14.6	40.7
Automotive Suppliers	29.2*	18.4*	52.4*
Not Automotive Suppliers	53.2*	12.5	34.3*
Automotive Suppliers	32.8	13.4	53.8
Japanese Transplants	29.2	18.4	52.4
Japanese-owned	28.8	20.7*	50.5
Japan-U.S. J.V.s	30.4	12.4	57.2
U.S.-owned	32.6	15.0	52.4

Note: *Difference of means is statistically significant at the $p < .001$ level by the chi-square test. Observations have been weighted to create estimates for entire population from which sample was drawn.