

**International Trends in Work Organization in the Auto Industry:
National-Level vs. Company-Level Perspectives**

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Changes in shop-floor work organization are a central part of broader changes in industrial relations in many industries around the world. In the automotive industry, the focus of this paper, international competition, new technological capabilities, and production system innovations have prompted many companies to move away from the dominant mass production model and to adopt new, flexible principles for organizing work that have demonstrable advantages in terms of economic performance. It is clear that these principles are often adopted selectively (and incompletely) and modified as they diffuse. What is less clear is how much variation in adoption occurs (and how extensive the modifications), whether the patterns of diffusion are driven more by national-level or company-level factors, and how closely work organization changes are related to the overall industrial relations system, which **does** vary considerably at the national level.

Past research on the transfer of principles of organizing work suggests that there is substantial national-level variation in how certain dominant principles are understood and applied, and that such variation is historically persistent (Kogut and Zander, 1992). For example, the overlapping principles of Taylorism and Fordist mass production that diffused broadly in the U.S. were also much studied by companies in Europe. However, the adoption of those principles in Europe was slow, partial, and affected by cultural influences at both national and company levels. In England, for example, Lewchuk (1988) argues that the persistence of craft traditions and the disdain of managers for involvement with shop-floor matters resulted in the adoption of Taylorist work organization with much less management control over work methods than in the U.S.

At the same time, pressures from the institutional environment -- from government and labor institutions and from company efforts to follow (what they believe to be) "best practice" -- may lead to convergence in work practices within a given country (Cappelli and Kochan, 1984; Baron, Devereux, and Jennings, 1986). Convergence within a given industry can be even more

pronounced, to the extent that work rules standardized across the industry are prominent in collective bargaining contracts. Thus past perspectives on the transfer of work organization argue for persistent **differences across** countries and **convergence within** countries and companies.

But I will argue in this paper that the emergence of a new set of dominant organizing principles in the auto industry has created the conditions for more **convergence across** countries and **divergence within** countries in work organization. These conditions affect the organization of work far more directly than they affect the broader industrial relations system, with the latter more likely to retain many country-specific characteristics despite the pressures for decentralization and responsiveness to local circumstances (Katz, 1993; Locke, 1992). But whereas national differences in industrial relations were likely, in the past, to dominate changes in work organization and create clear national patterns, I will argue that the forces for convergence across and divergence within countries are now more likely to overwhelm national differences.¹

Jürgens et al. (1993) address this issue in the world auto industry for the period 1983-1986, attempting to differentiate “company” and “country” effects. The authors carried out extensive field work at a "core sample" of seventeen plants from three companies (labeled A, B, and C in the book but clearly identifiable as Ford, GM, and Volkswagen) in three countries (U.S., U.K., and Germany). They find evidence of company differences in strategies for change in work organization at Ford and GM (the two companies with plants in all three countries), although with much more convergence across the Ford plants than across the GM plants. Underlying these differences, they argue, was the crisis faced by Ford (but not GM) in the early 1980s; Ford's emphasis on changing work organization and human resource practices as the primary response to their crisis, compared with GM (and VW's) greater emphasis on technical solutions such as advanced assembly automation; and the greater centralization of Ford's implementation effort, compared with the more decentralized approach at GM.

However, they also find strong country effects, particularly with respect to industrial relations and the institutional context for training skilled workers. In the U.S., given a history of

adversarial, “job control” labor-management relations, management at both Ford and GM emphasized work rule changes to achieve more flexibility in labor deployment coupled with efforts to boost employee participation and improve union-management cooperation. In the U.K., management struggles to pursue rationalization through greater shop floor control met with fierce union resistance and doomed most efforts at work organization changes. In Germany, a surplus of skilled workers and union efforts to reduce working hours combined with management's technical orientation and concern about high absenteeism led to the use of advanced automation on the assembly line and the creation of "off-the-line" subassembly areas with longer work cycles.

For the tumultuous time period they document, Jürgens and his colleagues find it difficult to discern dominant trends, concluding that:

We are faced with considerable difficulties in interpreting the direction and pace of change and getting to its essence.... A further problem lies in the fact that at the time of our research there was no established model for the new forms of work in the future, only many controversies about the direction to be taken.... The factor “industrial relations” proved to be an extraordinarily important influence. But also within management there were many different ideas -- about the necessity as well as the path of the reforms to be pursued. (p. 370)

On balance, however, they conclude that “the national affiliation of the factory site turned out to be a strong intervening factor which often came through more strongly than the influence of company affiliation.” (p. 379) Thus the findings of Jürgens et al. suggest that while strategies for changing work organization differed significantly at the company level, national factors associated with the industrial relations system had a stronger influence on what work organization changes were actually implemented.

I will revisit these issues in this paper to evaluate the many changes that have occurred in the auto industry since the time period of their study -- in their words, "the end of an age in the auto industry" yet a time when "the contours of the new production regime are barely visible" (p. 397). In the last ten years, there have been many new and intriguing developments in the auto industry to examine. U.S. and European companies have set up joint venture plants with Japanese competitors. Wholly-owned "greenfield" plants, like GM's Saturn and Volvo's Uddevalla, have

provided a "clean sheet of paper" for companies to experiment with new work practices. First Japanese companies and now German companies have set up new "transplant" facilities located away from their home base. Many existing plants have undertaken major changes in work organization when presented with both a carrot (the promise of new products or new investments in technology) and a stick (the threat of plant closure) by their company. Most significantly, with the rise in legitimacy and understanding of Japanese-influenced "lean production" principles, there has been more consensus across companies (although by no means unanimity) about the model for new forms of work that Jürgens et al. found to be manifestly lacking in the early 1980s, and more acceptance of this model by unions as the starting point for negotiations.

Drawing on longitudinal data (1989 and 1993/94) from an international sample of 86 assembly plants, I will update and extend the Jürgens et al. analysis by statistically evaluating the relative weight of company and country effects for work organization change, and addressing the question of which work organization trends have been convergent and which are divergent. While company effects appear to dominate country or regional effects for many variables -- including certain human resource policies, automation levels, and plant performance, both kinds of effects remain strong with respect to changes in work organization. Furthermore, while the **direction** of change in work organization is convergent, towards a "lean" or "flexible" production model, the **rate of change** differs dramatically across regional groups. Both the direction and rate of change in work organization can be linked, in most regions, to three prominent forces for convergence, described in the next section. However, various country- and company-specific factors that lead to divergence in work practices -- the focus of the paper's third section -- remain important for explaining variations from the dominant trends. The paper will close by discussing the implications of this analysis for assessing national-level vs. company-level effects on the transfer of new ways of organizing work.

Conditions for Convergence Across Countries

Three factors that promote convergence across countries will be discussed in this section: 1) the globalization of automotive markets; 2) the move towards more flexible, programmable forms of automation; and 3) the diffusion of lean production ideas and innovations. While all of these trends can be traced back 20-30 years, they have had the most impact on companies worldwide in the past 10 years.

Globalization of markets. It is relatively easy to document the common claim that the globalization of markets has had a massive impact on the competitive dynamics of the automotive industry and on the fortunes of auto companies worldwide. First, sales of vehicles made by non-domestic producers (either imports or produced at “transplant” facilities) have captured an increasingly large share of the market in many countries. The share of non-Big Three vehicle sales in the U.S. rose from less than 1% in 1955, the peak year for sales in the postwar period, to 18.4% twenty years later (1975) to a high of 28.5% in 1991, before falling back to 25.9% in 1994. The import share in European and Japanese markets is considerably less but climbing steeply, reaching 12% in Western Europe and nearly 5% in Japan by 1994. (Automotive News Market Data Book, various years)

Second, foreign-direct investment by companies in overseas production facilities and distribution networks is higher than ever, with the initial wave of investments (beginning in the 1920s and 1930s) by U.S. multinationals in Europe, Mexico, South America, Australia, and other developing economies now supplemented by a new wave (since the early 1980s) of Japanese investment in the U.S., Europe, Australia, and Asia, and even more recently by European company investments in the U.S. in the 1990s.

Third, there has been an explosion of cross-national strategic alliances in the auto industry, as companies look for opportunities to learn from each other, to share the risks of technological development or expansion into a new market, to fill gaps in each other’s product lines or distribution networks, and to build global economies of scale (Garcia-Pont and Nohria, 1991?).

To the extent that the globalization of markets brings more intensified competition for all

automotive companies (whether or not they are global competitors), it creates pressures for convergence towards whatever approach to work organization is most associated with market success. At the same time, by driving some companies (or their plants) out of business, it helps select for those work organization practices associated with competitive survival.

Flexible Automation. While programmable machine tools have been readily available since the 1960s, it wasn't until the 1980s that automobile companies began making substantial investments in flexible automation. The diffusion of flexible automation was slow due in part to being more expensive, particularly at first. But these new technological capabilities also did not fit well with the prevailing strategy of mass production companies -- to achieve massive economies of scale through high-volume production of a single model, using fixed tooling designed only for that model. But as the price of flexible automation has fallen and companies have reassessed their competitive strategy product portfolio plans, investments in flexible automation have risen dramatically.

Flexible automation allows for multiple products to be built in a single plant and/or for rapid model changes (both major and minor) over time. Investing in flexible automation thus facilitates strategies of more product variety and shorter product life cycles, and thus is a necessary complement to changes in product development processes that result in more products being generated from cross-project coordination and in faster time-to-market. Robotic weld and paint equipment can also be adjusted more easily to accommodate incremental process improvements or engineering changes.

Investments in flexible automation can potentially be a force for convergence in work organization, in several ways. The link between flexible work organization and flexible automation is not technologically determined; robots do not require teams to operate effectively, nor multiskilled workers. But the decisions to invest in robotics and to invest in new forms of work organization are increasingly interconnected in company strategies. This is particularly true in light of the well-publicized failures of technology-only strategies in the mid-1980s (at General Motors in the U.S. and, to a lesser extent, at Fiat and VW in Europe) and the observation that

many firms, under the influence of mass production traditions of high volume and minimal changeovers, do not always use the flexible capabilities of new automation. (Jaikumar, 1986)

There are many ways in which flexibly-deployed workers capable of effective problem-solving are critical to achieving the strategic goals associated with flexible automation. In plants building many different models, workers have heightened responsibility for accommodating greater product complexity without productivity or quality penalties, mastering a higher variety of tasks, making sure the right parts go on the right vehicle, working with team members to find the most efficient layout for parts and tools, and identifying the product-specific quality problems.

Flexible automation facilitates rapid changeovers from one model to another, but before such changeovers can be made, work methods must be revised and well-tested in advance to avoid quality problems during product launch. Workers who are accustomed to job rotation within and across teams and to involvement in *kaizen* activities that refine work methods over time are critical resources in achieving an effective changeover. Programmable automation also lends itself more readily to worker involvement in making incremental process changes.²

Lean Production Ideas. A third strong influence promoting convergence across countries is "lean" or "flexible" production principles and innovations. This factor both complements and supplements the factors listed above, since lean production emphasizes flexibility in both production organization and technology, and several companies using lean production have achieved performance advantages that have helped them become extremely effective global competitors.

The key features of a lean production system are: Just-in-Time inventory systems and other buffer minimization policies; rapid machine setups to allow small lot production by reducing changeover times; the use of "on-line" work teams, job rotation, and extensive training to develop multiskilled workers who can be flexibly deployed; small "off-line" problem-solving groups that involve workers in "kaizen" or continuous improvement activities. These innovations were mostly developed at Toyota by Taiichi Ohno in the late 1950s and early 1960s, and thus are often identified as the Toyota Production System (Schonberger, 1982; Monden, 1987; Ono, 1988))

They first diffused within Japan to Toyota's suppliers and eventually to its competitors (Cole, 1989). Mazda, for example, nearly went bankrupt in the mid-1970s. Crucial to its recovery was a decision to implement Toyota-like lean production methods.

By the late 1970s, the diffusion of lean production within Japan was well-advanced and Japanese automakers had substantial performance advantages over their U.S. and European counterparts, particularly with respect to labor productivity and quality (Cusumano, 1985). Then, Japanese companies began to transfer lean production organizing principles to overseas plants in the U.S. and Europe -- first Honda, Nissan, and Toyota, followed later by Mazda, Mitsubishi, Isuzu, Subaru, and Suzuki. While not uniformly successful, virtually all of these transplants achieved performance advantages over many American and European plants, particularly in their ability to achieve both high productivity and high quality (Krafcik, 1988). Furthermore, the transplants made relatively few modifications in their production system from the approach used in Japan. (Florida and Kenney, 1991). The modifications that were made (e.g. no seniority-based pay; no enterprise union; no rotation of workers across shifts; separate pay and promotion policies for "exempt" and "nonexempt" employees) did not affect work organization (Shimada and MacDuffie, 1987; MacDuffie and Pil, 1994).

The transplants had a strong "demonstration effect" in the U.S., particularly given prior expectations by American companies that Japanese competitive advantages were based on lower factor costs (e.g. wage rates) and on cultural attributes of their work force (e.g. group orientation, strong work ethic), neither of which would be available to them in the U.S. Lean production came to be seen more and more as an alternative production paradigm that could be applied in a variety of cultural contexts.

Lean production acquired additional legitimacy through the business press, through company-initiated benchmarking of themselves against Japanese competitors, and through a variety of joint venture projects that gave U.S. and European companies close access to Japanese learning models. M.I.T.'s International Motor Vehicle Program (with which I am associated) no doubt contributed to this legitimization process as well, both through its formulation of the lean

production model and its international benchmarking of manufacturing, supplier relations, and product development (Krafcik and MacDuffie, 1989; Womack, Jones, and Roos, 1990).

By the early 1990s, when industry recessions plunged such companies as General Motors, Mercedes-Benz, Volvo, and Fiat into crisis, the normative pressures to see lean production as the "best practice" route to recovery were very strong. Furthermore, with the discrediting of the "high tech" strategy for achieving competitive advantage at General Motors and (to a lesser degree) Volkswagen and Fiat, the idea took hold that new, flexible technologies needed to be coupled with the organizational flexibility provided by lean production to be used effectively (MacDuffie and Krafcik, 1992). Finally, lean production plants seemed better able to handle high levels of product complexity without incurring cost or quality penalties (MacDuffie, Sethuraman, and Fisher, 1995) -- a strategic advantage, given the enthusiastic response of consumers to a proliferation of product offerings.

“Unfreezing” of the Mass Production Model. The confluence of the three forces listed above has created conditions ripe for convergence in work organization across countries. Globalization of markets has put serious competitive pressure on the old mass production model. The perceived performance advantages of lean production, together with evidence of its transferability, have given it powerful legitimacy as the new dominant model for auto manufacturing. Flexible automation offers considerable strategic advantages over fixed automation, particularly with respect to meeting the growing market demand for product variety, but is most strongly associated with improved economic when coupled with more flexible organizational practices.³

Thus this point in time can be characterized as the interruption of a long period of stasis for the dominant model (mass production), during which new technologies and organizing principles take hold and slowly displace the old model. As new organizing principles become dominant, all firms in the industry must adopt them to maintain competitiveness, or face decline and possible death. Yet the change to the new principles can be extremely slow, since the new approach is likely to be destroy old capabilities and require the development of new ones. Thus firms may

resist adopting the new principles until they encounter a “competitiveness crisis”. Such a crisis can “unfreeze” a company from its past strategies, structures, organizational routines, and labor-management relationships and create an opportunity for fundamental change. As each firm undergoes this transition, the net result (over time) should be movement towards the new organizing principles. Thus the combined force of the globalization of markets, new flexible technologies, and the increased influence of lean production ideas should be convergence in work organization across companies.⁴

Conditions for Divergence Across Companies

Given the forces for convergence across countries described above and a tendency historically for industry-wide standardization of work practices **within** countries, why should work practices **diverge** across companies?⁵ Answering this question requires examination of a number of company-level factors: differences in the timing of a “competitiveness crisis”; perceptions from management and the union as to the source of a company’s problems and the best path to recovery; management's strategy for changing work organization and the union's response or counter-strategy; management and union experience with earlier efforts to change work organization (or perception of the experience of competing firms); and company capabilities for learning and access to learning models. (See Table 1 for summary information about these factors for a subset of U.S. and European companies.)

The significance of a competitiveness crisis, as noted above, is its ability to “unfreeze” a company from its past strategies, structures, organizational routines, and labor-management relationships to allow the opportunity for some fundamental rethinking. This “punctuates” the equilibrium situation to allow a new set of organizing principles to exert influence on a company. Yet the impact of such a crisis can vary depending on its timing. The first company to experience a severe crisis may benefit, paradoxically, by having an earlier incentive to change to more effective strategies, structures, and organizational practices. A company’s response to such a crisis will also vary depending on what diagnosis they reach about the source of the crisis (e.g. internal vs.

external) and how they frame the solution, (e.g. technical vs. organizational).

Furthermore, some management strategies for implementing work organizational changes are more effective than others, and are heavily affected by whether unions support or oppose management's plan (and whether unions have an alternate strategy of their own.) The history of past company experiences with work innovations (or the perceived experience of competitors) will affect the expectations and receptivity of workers, managers, and union officials to any new change efforts. Finally, some companies are better able to learn from the experience of other companies (often through explicit "benchmarking" comparisons, and some have greater access to such "learning models".

The U.S. "Big Three". In the U.S., each of the Big Three faced a "competitiveness crisis" at different times. Chrysler was first, nearly going bankrupt in the late 1970s. At that point, knowledge about Japanese production methods at the Big Three was limited and financially-strapped Chrysler had the fewest resources to investigate a different manufacturing approach. The perceived remedy for Chrysler's problems in manufacturing was defined mostly in terms of cost-cutting. Wage and benefit concessions and some loosening of work rules, negotiated with the UAW, became crucial to the company's recovery. But Chrysler's overall approach to work organization and the production system changed little in the early 1980s.

Chrysler's first experimentation with new forms of work organization came in the mid-1980s, a time of relative prosperity for the company, in the form of the Modern Operating Agreements (MOA) that were implemented at two assembly plants and four component plants (Department of Labor, 1991; MacDuffie, Hunter, and Doucet, 1995). The impetus for the MOA was threefold. First, the head of the Chrysler department of the UAW wanted to sponsor an "industrial democracy" initiative. Second, Chrysler hired a new vice-president of labor relations from the steel industry and gave him a charter to develop joint labor-management initiatives similar to those that had been successful at Ford. Third, Chrysler was finally in a position to make long-overdue investments in capital equipment and new products, and decided that investments should be contingent on changes in work organization at various plants.

The MOA initiative was bold in its reliance on collective bargaining as the means for full-scale changeovers of existing "brownfield" plants, involving the use of work teams, "pay for knowledge", and the decentralization of quality responsibilities. However, implementation was extremely slow. MOA was seen primarily as a labor relations initiative and not as being central to manufacturing strategy. As such, it was often disrupted by labor-management disputes on other matters. At plants where the local union was unwilling to implement MOA, Chrysler often introduced a Progressive Operating Agreement (POA) that was management-initiated and focused on increasing the flexibility of labor deployment through the elimination of job classifications and work rules. Chrysler showed little ability for cross-company learning during this time. While Chrysler had access to a "lean production" plant through their joint venture involvement with Mitsubishi in Illinois, this had little influence on the thinking about MOA.

MOA implementation was also affected by Chrysler's return to crisis conditions in the 1989-1991. This time, Chrysler's response focused on reforming product development. They sought out a variety of learning models among the Japanese companies (particularly Honda) and were able to move quickly to implement a "platform team" approach that enabled them to develop successful new products in 3 years - matching or exceeding Japanese product development benchmarks. With the return of high market demand, particularly for the product segments where Chrysler is strong (e.g. minivans), the company made a very successful comeback in 1993-1994.

However, there has been little effort to build beyond the MOA experience to achieve broad changes in work organization at Chrysler's assembly plants. Persistent quality problems in Chrysler plants reveal that much scope for improvement still remains. At least so far, Chrysler's competitive ups and downs have had relatively little to do with changes in their approach to work organization in manufacturing. In both competitive crises during the past 15 years, work organization has not been perceived as either a major problem or an important remedy for the company. This example reveals the limits to which competitive crises alone can explain changes in the approach to work organization.

Ford faced a financial crisis soon after Chrysler, although it was less visible because profits

from Ford of Europe concealed the extent of problems in North America. Ford had acquired 25% of Mazda in the late 1970s, and so had been exposed to Mazda's process of learning about Toyota Production System. Ford's top managers also defined the company's problems partly in terms of the company's rigid structure, its emphasis on narrow functional specialization, and its adversarial labor-management relations. Employee involvement and quality were endorsed as twin initiatives that could help the company overcome these past organizational problems.

While Ford engaged in less plant-level innovation than General Motors, it was more successful at changing labor relations at top levels. The effort to break down barriers between functional groups helped pave the way for more cross-departmental communication at the plant level and for more cross-training for workers. Finally, Ford's decision to focus heavily on quality improvement, with its "Quality is Job 1" campaign, helped promote more decentralization of quality responsibilities from inspectors to shop floor workers.

As Ford's fortunes began to improve in the mid-1980s, it became cautious about more far-reaching changes in work organization, such as teams. In part, Ford wanted to preserve good relations with the head of the UAW's Ford department, whose public position was one of opposition to teams. Ford also knew from experience that the UAW was willing to allow considerable flexibility at the plant level, as long as potentially controversial changes in work organization, such as the adoption of work teams, were avoided. Thus for Ford, changes in work organization were quite modest on the surface, yet more fundamentally linked to the quality-oriented strategy for competitive recovery than the more visible MOA changes at Chrysler.

Ford's caution about teams also derived from its observations of rival General Motors. GM had embarked on an ambitious "Quality of Work Life" program, jointly with the UAW, in 1979, emphasizing "off-line" QWL groups that addressed non-production-related issues in an attempt to boost worker satisfaction. At the same time, GM tried to open some non-union "team concept" plants in the South (the so-called "Southern Strategy") as well as at some "greenfield" plants around Detroit. The Southern Strategy failed almost immediately, as the UAW successfully organized the new plants in Oklahoma City and Shreveport, Louisiana. But teams became

associated in the UAW's mind with an anti-union strategy. Team efforts in Michigan and elsewhere soon ground to a halt. The most advanced team plant at GM during this time, the Fiero plant in Pontiac, Michigan, marked the first time that teams had been centrally involved in dealing with production-related issues. The closing of the Fiero plant due to poor product sales prompted further skepticism about the value of teams from the union and workers alike.

GM had another opportunity to learn about lean production from its involvement at NUMMI, its joint venture with Toyota. While the NUMMI story is well-known (Krafcik, 1986; Brown and Reich, 1989; Adler, 1992; Adler and Cole, 1993), it will suffice to say that GM did a terrible job of learning from NUMMI. GM top management and engineers expected that Toyota's advantages derived from technology and that hiring back the workers and union officials from the former GM Fremont plant would be a liability for Toyota. So GM completely overlooked the different approach to organizing production work and the greater emphasis on worker skill and motivation as the source of NUMMI's impressive performance. Although they exposed hundreds and possibly thousands of GM employees to NUMMI for short, 1-day visits, complete with plant tour, these visits did not reveal the different "logic" at NUMMI and, if anything, bred skepticism about NUMMI's value as a learning model.

The crisis at GM came much later than at Chrysler and Ford, in part because of the company's size and wealth. By the time it hit GM, in the early 1990s, the company had lost so much market share and closed so many plants that it was in an extremely difficult position from which to implement new work practices. With staggering losses, big cost savings were needed quickly. Workers were cynical about management intentions and trust was low. As a result, GM has taken a more "top-down" approach to lean production in the last few years, primarily through its Synchronous Manufacturing program, which carries out process reengineering efforts (primarily driven by industrial engineering staff) at the plants.

So depending on the timing and nature of their "competitiveness crisis", each of the Big Three companies experienced the "unfreezing" effect that can facilitate the adoption of new work practices to a different extent. The companies also differed in their perception of whether "lean

production" was the right path to follow, strategically, with Ford the first to move in this direction, followed by Chrysler, and only belatedly by GM. Ford appears to have made the best use of its learning relationship with a Japanese company, with both Chrysler and GM having more difficulty absorbing the lessons from their joint venture experiences. GM's unhappy experiences with QWL and "team concept" served to scare off Ford and slow Chrysler's willingness to pursue this approach, as well as making it more difficult for GM to bring about work organization changes when it was finally faced with a major competitiveness crisis.

Europe. In Europe, the movement towards lean production has been more recent and, to a greater extent than the U.S., reflects the trends towards convergence. Furthermore, for European companies that have all their plants within a single country, it is difficult to untangle company and country effects. But the factors identified above -- the timing of a competitiveness crisis, perceptions of the best path to recovery, management strategies and union responses, and capabilities for learning -- do help identify important differences across companies in Europe, particularly during the 1980s.

By the mid-1980s, for example, Renault was facing a major competitiveness crisis and chose to embrace lean production as a way out of their difficulties and as an alternative (given severe financial constraints) to making heavy investments in technology. This required the company to reach agreement with its unions, in both France and Belgium, on a new contract allowing significant changes in work organization at its existing plants. Peugeot, in contrast, faced no such crisis. With its CEO leading the campaign within the EC to keep Japanese companies from building plants in Europe or boosting their exports, Peugeot had little interest in adopting a Japan-influenced model and did not pursue the same kind of work restructuring through collective bargaining as Renault.

Also in the mid-80s, Fiat was just reopening its Cassino plant, heralded as the most automated assembly plant in the world, and a reflection of Fiat's intent (following a financial crisis in the late 1970s and a bitter strike which was won decisively by management) to reduce its dependence on workers (Locke, 1992; Camuffo and Volpato, 1994). Volvo, during this time,

was preparing to open its Uddevalla plant, the most ambitious in a series of plants with socio-technical designs -- in this case, with no moving assembly line -- intended to help it attract Swedish workers into manufacturing jobs and reduce high levels of absenteeism and turnover. Volvo was also continuing its efforts to implement “off-line assembly” and other socio-technical design concepts in its other plants in Sweden, Belgium, and Holland (Berggren, 1992).

Volvo’s example was in turn influencing both Volkswagen and Mercedes in their planning of “off-line” assembly areas for new plants at Emden and Rastatt. But Volkswagen at this time was also committed, like Fiat, to a “high tech” strategy for reducing direct labor in assembly, though motivated more by a desire to utilize its highly skilled technical workers and improve ergonomic working conditions rather than by a move away from reliance on workers (Jürgens et al, 1993; Turner, 1991).

When a competitiveness crisis hit these four companies -- Fiat, Volvo, Volkswagen, and Mercedes -- in the early 1990s, each responded in different ways. Fiat abandoned its “high tech” strategy and negotiated plans with its unions for a new plant (Melfi) that would utilize team structures (UTE, or Elementary Technical Units), performance-based pay, and other new forms of work organization. (Camuffo and Vicelli, 1995) Volvo closed its two innovative socio-technical plants, Kalmar and Uddevalla -- in response, according to some observers (Hancke, 1993; Berggren, 1993), to pressure from Renault (briefly their partner-in-alliance), which was convinced of the greater virtues of Japanese-style team structures. Volkswagen negotiated new arrangements with IG Metall and its works councils for work hour reductions and pay freezes to minimize layoffs during a period of reorganizing of production, and increased its utilization of “group work”⁶, building on pilot projects from the mid-to-late 1980s (Jurgens, 1995; Roth, 1995). Mercedes-Benz accelerated its move away from craft methods and boosted investments in automation, while backing away from the Volvo-influenced production system at Rastatt and hiring a Japanese consulting firm to implement “lean production” at its new U.S. factory.

For the American-owned companies in Europe, company differences were also pronounced. As in the U.S., Ford of Europe got a fast start in the early 80s (with its “After

Japan”) on implementing employee involvement activities directed at quality and improving labor-management relations. However, unlike Ford in the U.S., these were boom years for Ford Europe and the early experiments with work reorganization were short-lived. However, Ford had laid the foundation for more cooperative relations with its unions and works councils, enabling them to revive some quality-oriented initiatives later in the 80s (in connection with learning exchanges with Mazda plants), while proceeding cautiously (as in the U.S.) with teams and other new work structures.

GM of Europe, on the other hand, did face a severe financial crisis in the early 1980s that set the company on a path of learning about lean production, unlike GM in the U.S. This strategic redirection resulted not only from the competitiveness crisis but from the appointment of new top managers (first Jack Smith and then Lou Hughes) who had helped to set up the NUMMI joint venture and had become convinced of the value of lean production principles. While there is still more variation in Europe across GM’s plants than for Ford, GM has gone further than Ford in establishing more far-reaching reforms in work organization at some of its plants (Turner, 1991).

For example, the most advanced lean production plant in Europe that is not Japanese-owned is the new GM Europe plant in Eisenach in eastern Germany, which is run primarily by young American and Canadian managers and advisors who previously worked either at NUMMI or at GM's joint venture plant with Suzuki in Canada (CAMI). Eisenach's achievement owes much to GM Europe's strategy of trying to replicate lean production principles developed elsewhere, without major efforts to reinvent or modify them, and to the extensive transfer of managers with extensive "hands-on" experience with lean production to oversee the launch effort. Eisenach has also benefited from its greenfield status and its workforce -- workers from the former East Germany who have no previous experience in a traditional mass production plant and who have shown a strong interest in adopting "group work".

So most European companies that faced competitive crises early in the 1980s pursued different strategies for improvement, depending on whether they were primarily oriented towards technology (Fiat, VW) or “people” (Volvo, Ford) solutions (Jürgens et al, 1993), whether they

had adversarial (Fiat, Renault) or cooperative (Volvo, VW) relationships with unions and works councils, their past experience with work organization reforms (especially at Volvo and VW), and the influence of "learning models" (e.g. Volvo's socio-technical experiments for VW and Mercedes, Mazda for Ford Europe, NUMMI for GM Europe). GM Europe and Renault were the only European companies during the 1980s to make serious moves, company-wide, towards lean production, due to the timing of competitive crises, the orientation of their leadership, and their capacities for learning. Thus it is only after the competitive crises of the early 1990s that the responses of the European companies begin to look more convergent, as will be discussed below.

Japan. Even in Japan, there is substantial divergence across companies, although largely within the bounds of the lean production model. The diffusion of Toyota's production methods in the 1970s, mentioned above, did mean that most companies were adhering to the most visible aspects of lean production, particularly the Just-in-Time inventory system and the use of formal work teams and quality circles. However, sizable differences remain in how well companies understand Toyota's innovations and how successfully they have been able to maintain lean production practices in the face of various challenges -- e.g. industry downturns, increasing product variety, major automation initiatives within the assembly area. Nissan, for many years, resembled U.S. companies in its emphasis on automation and economies of scale and its relatively traditional work organization. (Cusumano, 1985) Even after adopting much of the structure of Toyota's work organization, Nissan was much less successful at getting workers involved in "kaizen" activities. During a visit to a Nissan plant in 1992, I received an extensive presentation about a newly-initiated campaign for "workshop management" consisting of kaizen-type activities that had been carried out at Toyota plants for at least fifteen years.

These differences are also apparent when examining the "transplant" operations of various Japanese companies in the U.S. Nissan yielded substantial authority to the first American manager of its Tennessee plant over such issues as plant design, and ended up with the most space-inefficient plant in North America. In addition, many of Nissan's HR policies in Tennessee bear a closer resemblance to the U.S. nonunion model than to employment practices in Japan (Shimada

and MacDuffie, 1987). Unlike Toyota, which built a very effective working relationship with the union at NUMMI, Mazda made several mistakes in its handling of the union and the workforce at its plant in Michigan -- with management first building overly-rosy expectations during an endless hiring and training process, then reversing its position on several key issues, such as training and temporary workers, during the pressures of the first year of production (Fucini and Fucini, 1990). The smaller Japanese companies -- Mitsubishi, Suzuki, and the Subaru-Isuzu joint venture -- have all had some difficulties simultaneously managing lean production and an American work force at their transplant facilities (e.g. Huxley, Rinehart, and Robertson, 1995).

A thorough examination of the source of differences among the Japanese companies is beyond the scope of this paper. But it can be said that, like U.S. and European companies, each of the Japanese companies has experienced competitive crises at different times, has a different history of experiments with work reforms, and different relationships with its enterprise union. While the Japanese companies may share a greater consensus about pursuing the Toyota Production System model for work reorganization than in other countries, there still appear to be strong differences in the learning capabilities of the different companies, particularly with respect to transferring these work practices to countries outside of Japan.

Summary. In all three regions, company-level factors lead to significant divergence in the adoption of new forms of work organization despite the strong forces for convergence outlined above. Some of this divergence represents differences in the timing and severity of a competitive crisis that “unfreezes” the company and increases its readiness for fundamental changes, some of it is based on differences in company capabilities for implementing such change, and some of it reflects more durable differences in company strategies. While considerable company-level divergence is apparent during the past 10-15 years, a time of major transition in organizing principles, it is less clear whether these differences will persist or whether they represent different starting points and different rates of change towards what may be a more convergent “steady state” in another 10-15 years.

Comparing Regional Changes in Work Organization Over Time

The previous sections describe the convergent and divergent forces for change in work organization. In this section, we examine the regional trends in the adoption of “flexible” or “lean” work practices as well as trends for flexible automation and product variety, which are hypothesized to be promoting the diffusion of new work practices. These trends provide an initial basis for evaluating the main hypothesis of greater convergence in work practices across countries and regions.

Evidence concerning changes in work practices (and other factors affecting the adoption of work practices) across countries and regions is presented in Table 2a and 2b. I draw upon 1989 and 1993/94 data from the International Assembly Plant Study (see also MacDuffie and Pil, 1995). I will compare regional averages across six groupings of plants -- Japanese-owned plants in Japan (Jpn/Jpn), Japanese-owned plants in North America (Jpn/NA), U.S.-owned plants in North America (US/NA), all U.S. and European-owned plants in Europe (Eur/Eur), plants in Newly-Industrialized Countries (NIC), and plants in Australia (Aust.)

Table 2a first considers regional changes from 1989 to 1993 for specific work practices -- the percentage of the workforce in teams and employee involvement groups, the extent of job rotation, the number of suggestions per employee and the percentage of suggestions that are implemented -- and then shows the Work Systems Index score which is based on aggregating these practices.⁷

The top half of the table contains data from the matched sample of 38 plants participating in both Rounds 1 and 2 of the assembly plant survey, while the bottom half of the table contains data from the entire Round 1 and Round 2 samples. The matched sample offers the most precise look at change in the same set of plants over time but with a small sample size. Conversely, the larger unmatched samples offer a more representative view of dominant practices in each region at the two points in time, albeit with compositional differences in the plants included in each sample. The fact that both views of the data reveal roughly similar patterns suggests that the results discussed below are not substantially affected by sample bias problems.

Work Organization. The most striking trend in Table 2a is the huge increase in European, New Entrant, and Australian plants in the use of small group activities -- both "on-line" work teams and "off-line" employee involvement groups -- as well as increased job rotation and reliance on suggestion systems. In contrast, small group activities at the U.S.-owned plants in North America affect fewer employees than in any other region and problem-solving activities (i.e. suggestions received per employee and the percentage of suggestions implemented by management) also remain low for the Big Three plants even as they increase for European, NIC, and Australian plants (as well as the Japanese transplants).⁸ Job rotation is the only practice to have significantly increased in all regions. Increased concern about ergonomic problems and repetitive strain injuries may provides a common motivation for job rotation across companies, irrespective of the company's commitment to job rotation as a means of learning multiple skills.

Plants in Japan remain the most consistent followers of "lean" work practices. They do show some diminution in their adherence to certain practices, which seems to be most likely due to recessionary conditions in the Japanese auto industry that carried through 1993 and 1994. In contrast, the Japanese transplants in North America appear to be on a steady trajectory converging upon the practices of their counterparts in Japan, although their percentage of workers in employee involvement groups and suggestions received and implemented remains considerably lower than in Japan.

On the strength of this evidence, it seems reasonable to claim that the **direction** of work organization changes is converging towards lean or flexible production work practices.⁹ The changes in Europe, NIC, and Australian plants can perhaps also be accurately described as convergent in **degree** or extent of change as well. Here I would argue that the appropriate comparison is to the Japanese transplants rather than Japanese plants in Japan. The implementation of lean production in Japan has been going on for over 30 years, while implementation in the transplants as well as in any other plants that are moving towards lean production has occurred in the last 5-10 years. For most of these variables, the difference in means in 1993/94 when comparing the Japanese transplants with European, NIC, and Australian plants is not statistically

significant. However, while Big Three plants in the U.S. and Canada may be converging in direction, their **degree** of implementation of flexible work organization clearly **diverges** substantially from other regions.

Automation. Table 2b provides data on two measures of technology: Total Automation, which measures the total number of physical production steps that are carried out by automated equipment rather than people (e.g. the number of welds, the square inches of paint applied, the assembly operations; and the Robotic Index, which measures the number of robots (defined as programmable automation with three or more axes of motion) in the weld, paint, and assembly areas adjusted for the plant's production volume.

Considering Total Automation first, which does not distinguish between fixed and flexible automation, we can see a small increase in automation in most regions. While the direction is consistent with the historical trend, the relatively small size of the increase may be due to the fact that automation levels have remained relatively flat in the weld shop (where many modern plants in the U.S., Europe, and Japan are approaching 90-95% automated welds) and in assembly operations (where automation remains costly, unreliable, and surprisingly difficult to shift across models, causing companies in all three regions to back away from ambitious investment plans in this area). Thus major boosts in automation level at modern plants are mostly occurring in the paint shop. In contrast, results for the Robotic Index reveals a strong shift towards flexible automation. With levels of total automation relatively unchanged, this means that flexible automation is being substituted for earlier generations of fixed or hard automation at a rate that is facilitated by steady improvements in the price/performance ratio for this equipment.

Japanese-owned plants, both in Japan and the U.S. have the highest level of flexible automation in both 1989 and 1993 and a higher rate of growth in the use of robotics over this time period than U.S. and European plants, which are similar in their level and rate of growth in robotics. The high percentage change in the level of robotics for the NIC plants, particularly in the unmatched sample, is primarily the result of a number of newly-built Korean plants that were designed to be "high-tech". There is virtually no change in flexible automation among the

Australian plants because they typically have neither the production scale (most make under 50,000 vehicles as year) nor the manufacturing capabilities (having operated for years in a protected market) to attract much capital investment.

Thus these data provide mixed support for the hypothesis that investments in flexible automation create an incentive to move towards more flexible forms of work organization. The extremely high level of flexible capabilities, both technological and organizational, at the Japanese plants in Japan and North America supports the idea that “fit” between these capabilities is important, even if it does not conclusively indicate the direction of the causality.¹⁰ Similarly, the relatively large jump in the Robotic Index for European and NIC plants matches the jump in their scores for various work practices. U.S. “Big Three” plants are again an exception to this trend.¹¹

Product Variety/Complexity. The product variety/complexity data in Table 2b are drawn completely from the Round 2 survey, in which respondents were asked to answer a more specific and detailed list of questions about changes in product variety for 1990 and 1993.¹²

Plant that built lots of models are likely to benefit from heavier reliance on flexible automation and flexible work organization. Trends for the number of models are mixed but do not show dramatic change over this three-year period.¹³ Japanese plants in Japan make the most models in each plant, consistent with their high-variety product strategies. Low-volume NIC and Australian plants also produce relatively high variety since there is insufficient market demand to justify dedicating a single plant to one product. The Japanese transplants, which started with extremely low product variety to facilitate the learning process, continue to add more different models to their plants over time. While the number of models holds steady in Europe, it actually drops in the U.S., where the Big Three have been more inclined to see product variety as being detrimental to achieving high productivity and quality in manufacturing and have made determined efforts to cut it back.¹⁴ Thus one source of incentive to develop more flexible forms of work organization -- increasing product variety -- is lacking for the Big Three plants (MacDuffie, Sethuraman, and Fisher, 1996).

Another indicator of increasing product variety driven by the globalization of markets is the

trend of plants exporting vehicles to more and more countries, which is consistent across all the regions, although with high variation in the amount of export activity. Although Big Three plants showed the highest percentage increase (93%) from 1990 to 1993, their level of export activity is still comparatively low and may not yet exert much influence on decisions about work organization. In contrast, export activity is quite high for European plants in 1993/94, which fits with their greatly increased utilization of flexible work practices. However, the causality is uncertain since the level of European exports was not much lower in 1990, while work practices that year were still mostly traditional. This would support an argument that the European move to flexible work organization has been overdue, given their past levels of flexible automation, product variety, and export activity.¹⁵

The other three measures -- the number of wire harnesses, the number of exterior colors, and the number of engine/transmission combinations built at each plant -- represent more intermediate levels of product variety that are not so apparent to the consumer but pose massive difficulties in terms of greater manufacturing complexity.¹⁶ For these variety indicators, there are again large regional differences, with the highest levels in regions that export heavily.¹⁷ The overall trend is for modest increases in all three kinds of product variety except, once again, for Big Three plants in the U.S. that have been attempting to reduce manufacturing complexity. Both the differences in levels across regions and the trends over time fit the patterns of utilization of flexible work organization, most notably in Japan (high variety=high flexibility) and the U.S. (low variety = low flexibility).

Other Production Organization Policies. Table 2b also includes data for two indices of production organization that, in past work, I have found to be highly intercorrelated with (and complementary to) changes in work organization: the Use of Buffers and HRM Policies index (MacDuffie 1995). The former refers to manufacturing policies affecting inventory levels for both incoming parts and work-in-process, and thereby captures the extent to which a plant is following a Just-in-Time inventory policy. A higher score means a **reduction** in buffers, i.e. a move to “leaner” buffers. The latter refers to such HRM policies as the use of contingent compensation, the

presence of status differentiators, and the level of training for new and experienced employees. A higher score indicates “high commitment” HRM policies.

Examining primarily the unmatched samples, we find substantial convergence in level across regions for the Use of Buffers index, with Japanese-owned plants (both in Japan and the U.S.) increasing their inventory levels (very likely because of the impact of the recession on the JIT system in Japan and the increased amount of domestic sourcing of parts for the transplants) and U.S., European, and NIC plants decreasing their buffers. (Australia’s huge increase in buffers is an unresolved puzzle.) This suggests that the lean production view of buffers as *muda* (waste) to be eliminated has been quite influential on inventory practices worldwide. But given the lack of variation in buffer policies and high variation in work practices, it is clear that a move towards JIT inventory practices is not always linked to the adoption of flexible work practices.

In contrast, patterns of change for the HRM index are better predictors of work organization changes. European and Australian plants are the most enthusiastic adopters of new HRM policies in recent years, as they are for small group activities. Japanese plants, both in Japan and the U.S., have remained relatively constant in their HRM policies, while Big Three and NIC plants have shown a most modest increase in their HRM index scores, primarily due to an increase in training activities.

The massive change in the HRM index score for Australian requires some explanation. It is the direct result of a country-specific factor related to industrial relations -- a new agreement reached between the industry association and the metalworkers union in response to the deregulation of the Australian industry (Automotive Industry Authority, 1989). This agreement introduces a new “pay-for-skill” compensation plan and a training qualification program intended to boost both basic and technical skill levels throughout the automotive workforce (Lansbury and Bamber, 1995). Since both new pay plans and increased training are part of the HRM Index, these changes have a substantial impact on the scores of the Australian plants.¹⁸

Also worthy of further discussion is the dramatic increase in the implementation of formal work teams and problem-solving groups in European plants and the absence of such changes in the

U.S. In Europe, the rapid move to "group work" reflects the confluence of a number of conditions. Many European companies were already experimenting in the 1980s with work teams in subassembly areas of some plants (Turner, 1991; Jürgens et al, 1993). At the same time, European unions, particularly in Germany and Sweden, were studying different approaches to "group work" internationally, contrasting in particular the Japanese model found at NUMMI and other U.S.-based transplants with the socio-technical model used by Volvo at its car and truck plants (Berggren, 1992; Roth, 1995). For much of the 1980s, these unions were more likely to advocate the adoption of "group work" than management, which was not convinced that this change in work organization would lead to performance gains. As Turner reports, in his case study of GM Europe's Bochum plant:

As early as 1982....., the union and works council demanded better protection for displaced or downgraded workers and called for alternative forms of organization, including group work. According to works councillors, management bargainers laughed at proposals for group work (a union pipe dream) until 1987-88, when management developed its own interest in teams. (p. 128-129)

In the late 1980s and early 1990s, the combination of a competitive crisis for many European companies and the legitimation of "lean production" as a model appears to have convinced managers of the need to implement "group work" as part of an overall shift in production system strategy. Unions have supported this move, it appears, because they see the opportunity to advance their own agenda and the interests of workers by supporting this initiative. There is certainly some ambivalence about this change among managers, union officials, and workers. It is too early to tell whether "group work" will be viewed as instrumental in boosting performance. Also, it is unclear whether "group work" will win widespread acceptance and become a permanent feature of work organization in European plants.

The rapid move towards "on-line" and "off-line" group activities in these regions is a strong contrast with the U.S., where movement towards lean production work practices has been quite limited, although many associated manufacturing policies (e.g. buffer reduction) have been implemented. There are many company-specific factors that help explain this limited diffusion, as

noted above, and some common factors associated with industrial relations: first, the political controversy around the idea of a "team concept" within the United Automobile Workers (UAW) union, where opposition to teams was a central feature of the New Directions faction in the 1980s; and second, management caution after the failure of several early experiments with teams in the late 70s and early 80s. As a result, less convergence towards flexible work practices can be seen in the U.S. in 1993 than would have been evident five to ten years ago. This pattern may also be changing again, with evidence that the U.S. companies (most notably Ford) are increasingly likely to convert plants to team-based work organization whenever a major retrofit of a plant for a new product allows time for extensive training and other preparation. If the most recent (and pending) implementations of new work practices at Big Three plants turn out to be more durable than the wave of experimentation in the early 1980s, the U.S. trend may come to resemble trends in the rest of the world within the next 5-10 years. However, U.S. plants may also continue to be anomalous cases. If so, it will be important to determine whether U.S. companies are also resistant to other global trends (e.g. towards high product variety) or whether it is only the area of work organization that shows distinctly different patterns from other regions.

Company-Level vs. Country-Level Explanations for Change

Given that there is evidence of both convergent and divergent trends in work organization, the next question is how to assess the relative importance of national/regional vs. company influences, both for work organization and other aspects of the production system. This requires a comparison of plants from the same company that are located in multiple regions, and of plants in the same region that are owned by multiple companies.

In this section, I will examine a subsample of 31 plants from the 1993 survey that meet these conditions, with at least three plants from a given company in two regional groups, i.e. a minimum of six plants per company. Three companies are represented -- labeled A, B, and C for confidentiality reasons -- and all plants are located in North America, Europe, or Japan. These three companies do have plants outside of these three regions, but we do not have data from a

sufficient number to warrant including them in the comparison. Of the 31 plants, 18 are in North America, 9 are in Europe, and 4 are in Japan. To preserve confidentiality agreements with the companies, I cannot reveal any additional details about Companies A, B, or C and I will present only limited data.

While analyses of this kind typically emphasize country effects rather than regional effects, the data do not allow for country-level analyses. For example, the nine plants in Europe are divided among four countries, too few per country for any meaningful statistical analysis. While there are certainly differences among plants in Europe, they are relatively small for these nine plants in relation to the more significant differences across regions.

I will focus on the three categories of variables analyzed above: automation; product variety; and production organization (e.g. use of buffers, work systems, and HRM policies). In addition, I will examine differences in plant productivity and quality.

To illustrate the logic of this analysis, consider the automation variable. If the level of automation across all the plants in this subsample is similar (i.e. no statistically significant difference in group means), it may indicate an industry effect rather than company or regional effects. A certain level of automation may be necessary for competitive survival across the industry, at least in the advanced industrial nations in this subsample, with relatively little benefit in acquiring automation beyond the level necessary to meet the competitiveness threshold. If automation levels reveal significant differences by company but not by region, it would imply differences in company automation strategies that prevail across different locations. If, on the other hand, automation levels differ by region but not by company, it would imply that company investment choices are differentially affected by regional factors, such as the availability of technical support or skilled workers or wage rates.

The same logic would apply to other variables, such as the use of work teams. Similar levels across all companies and regions would imply competitive necessity. Significant company (but not regional) differences would suggest that company strategies are the dominant influence on diffusion patterns. Significant regional (but not company) differences would suggest that

country/regional factors such as worker characteristics, labor-management relations, the union position on teams are more influential than company-specific strategic plans.

Table 3 present means across the various company/regional groupings of plants, and Table 4 shows the results of t-tests for statistically significant differences. For the performance variables, confidentiality agreements prohibit revealing company-specific averages (even with the companies disguised) in Table 3, but the significance level of t-tests for differences in productivity and quality means across the six groupings in this subsample are included in Table 4

Plant performance. T-test results here indicate that the “company effect” for both performance measures appears to be dominant, as for other variables. The only significant regional difference among the three productivity comparisons and one quality comparison is for productivity between Company A’s U.S. and European plants. In contrast, there are pronounced differences in both productivity and quality across companies in three out of four of the productivity comparisons and two out of three of the quality comparisons.

Automation. The two automation measures show strikingly different patterns. Levels of Total Automation are relatively similar across these plant, but more pronounced company differences are evident for the Robotic Index. For both automation measures, there are both company differences and a "home country" effect; the Company A and Company B plants in the U.S. have more automation than their European counterparts, as do the Company C plants in Japan compared to their U.S. transplants. It seems likely that the higher production volume that companies normally produce in their home country might provide the economies of scale to justify more extensive automation investments.

T-tests in Table 4 reveal different results for the two automation variables. For Total Automation, there are no significant differences across any of the groupings, suggesting that overall automation levels are indeed determined more by industry competitive requirements, at least for these advanced industrial economies, than by regional or company differences. For the Robotic Index, company differences are more pronounced, although there is a significant difference between Company B’s U.S. and European plants on this variable.

Production organization indices. Recall that the Use of Buffers index captures such manufacturing policies as levels of incoming and work-in-process inventory and the approach to vehicle repair, with higher scores reflecting smaller or "leaner" buffers. A priori, these policies would seem to be primarily influenced by company-level choices and capabilities. (Although there are likely to be regional differences in the capabilities of suppliers to support a Just-in-Time system.) Here, company-level influences do appear to be predominant, with Company C plants being the "leanest", followed by Company A and then Company B.

The HRM Policies index includes training, contingent compensation, hiring philosophy, and degree of status differentiation. With the possible exception of training, these are primarily established at the corporate level. The training variable measures in-plant training activity, both on-the-job and off-the-job, and thus would not pick up the apprenticeship-based training that is prominent in some European countries (and not in the U.S.). Here, the most striking pattern is the similarity of the means for Company A and Company B, in both the U.S. and Europe. Furthermore, although plants of European-owned companies are excluded from this subsample, their mean score for the HRM Policies index (not shown) is higher than the mean for U.S.-owned Company A and Company B plants in Europe. This pattern suggests that corporate guidelines for these HRM policies at Companies A and B are sufficiently strong to produce relatively uniform outcomes across different regions.

For the Work Systems index, the summary measure of work organization practices, there are intriguing signs of both regional and company effects. Clear differences in company strategy are apparent. Company C plants tend to have the highest scores on this index, followed by Company A and then Company B. Factors discussed in the "company-level divergence" section above -- such as the timing of competitive crises, management and union perceptions of past experiences with work organization changes, and organizational capacities for learning -- help explain these differences.¹⁹ Nevertheless, consistent with the overall trend for Europe, the Work Systems mean is higher for the European plants of Company A and Company B than for their U.S. plants. As discussed above, this regional difference is rooted partly in the different stance of

European and American unions towards “team concept” or “group work”.

For both the Use of Buffers and HRM Policies, the t-tests in Table 4 are only significant across companies, not across regions. But for the Work Systems index, the t-tests reveal significant differences in means for both regional and company comparisons. The implications of this finding will be discussed further below.

Link Between Flexible Technology and Flexible Work Organization. This analysis reveals an intriguing relationship between the pattern of findings for the Robotic Index and Work Systems. The use of “flexible” work systems -- characterized by teams, problem-solving groups, job rotation, and active suggestion systems -- tracks the use of flexible automation very closely.

The highest mean score for both technology and work organization variables is found at Company C plants in Japan, with substantially lower mean scores at Company C's U.S. plants. The lowest mean score for both variables is found at Company B plants in the U.S. Company B's European plants have mean scores for both variables that are higher than Company B's U.S. plants and statistically significant. The only variation from this pattern is found at Company A's U.S. plants, which have the same (relatively high) level of robotics as Company A's European plants but a lower usage of flexible work systems, to a statistically significant extent. This suggests that in Company A's U.S. plants, there is insufficient investment in flexible work systems relative to the investment in flexible automation -- unlike Company B, where the low scores for both variables are well-matched.

Conclusions and Implications

The paper updates and extends the inquiry of Jürgens et al. (1993) into convergent and divergent forces for change in work organization in the world auto industry, with a hypothesis suggesting more convergence across countries and divergence across companies than in the past. The regional examination of Round 1 and Round 2 data from the International Assembly Plant Study that follows (Tables 2a and 2b) reveals a mix of convergent and divergent trends with

respect to the adoption of flexible work practices. The **direction** of change in work organization is convergent, towards a “lean” or “flexible” production model, while the **rate of change** differs dramatically across regional groups. Both the direction and rate of change in work organization can be linked, in most regions, to the general forces for convergence highlighted above -- the globalization of markets (reflected in more models being produced, more export activity, and hence more manufacturing complexity), the move towards flexible automation, and the influence of lean production ideas and policies (particularly complementary policies on the use of buffers and HRM policies). Where these links are not seen, the various country- and company-specific factors that account for divergence must be examined.

European plants show the most fundamental shift in their approach to work organization from 1989 to 1993/94, with NIC and Australian plants close behind. This can be partially explained by technology and product variety trends in these regions, but also requires a more institutional analysis of the influence of lean production ideas and, for Europe and Australia, the impact of a strong union role in shaping (and implementing) new policies affecting work organization. Japanese plants, both in Japan and the U.S., provide the best evidence of the “fit” between flexible work organization, flexible technology, and a high variety product strategy. Finally, “Big Three” plants in the U.S. and Canada show the least amount of movement towards flexible work practices, and present the most anomalous results. This is particularly true given that most of the global trends highlighted above can be seen in the U.S. as well as in the other regions. However, it must be noted that the U.S. companies seem to have made less investment in flexible automation than companies in other regions, and are also intent on reducing their levels of product variety -- both strategic decisions that reduce their incentive to make changes in work organization.

For Europe in particular, the extent and rapidity of the shift towards more flexible work practices owes a great deal to the long-time interest of European unions in experimenting with “group work”. Compared to the U.S. situation, the relatively well-developed policy stance of European unions towards “group work”, the higher level of political consensus within these unions about the potential benefits of these new work structures for workers, and the tradition (and

past experience) of working with management to find mutual gains at a time of competitive crisis are all factors that facilitated this change.

In cross-sectional comparisons across companies and regions for the subsample of 31 plants, the results of t-tests shown in Table 4 reveal far more statistically significant differences in means on the right-hand side of the table -- across companies, within regions. This suggests the primacy of a "company" effect over a "regional" effect for many of these variables (e.g. performance, automation, human resource policies) although, as noted above, for new work practices, both company and regional effects appear to be strong. These results must be interpreted with caution. It is possible that some of the regional differences in means revealed here are not statistically significant because the sample size is too small. Nevertheless, the greater strength of company-level factors relative to regional-level factors seems clear despite constraints on statistical power.

In both analyses, company differences in automation and product variety strategies appear to play an important role in influencing adoption of flexible work organization. The "pull" towards flexible work organization created by these strategic variables may be the most important reason for the dominance of company-level effects. Indeed, differences in the competitive strategy of companies may be particularly influential in driving divergent approaches to work organization, within the more global trend of convergence towards lean production principles that is driven by the market and technological forces identified above.

For example, with the caveat that not all company strategies reflect the linkage between flexible work systems and flexible automation hypothesized here, we can make certain predictions for the companies examined above. We would expect Company C to continue to move, at its U.S. plants, towards the level of flexible work systems found at its plants in Japan. In contrast, Company B could be expected to retain low levels of both flexible automation and flexible work systems until (or unless) it shifts strategy in the direction of higher product variety and significantly shorter product life cycles. Company A should be willing to invest more in flexible work systems

in its U.S. plants, to complement its already-high investment in flexible automation. However, all of these changes may be affected by regional or national-level factors affecting work organization.

In conclusion, the purpose of this paper is not to argue that national-level differences in work organization have disappeared completely, or will someday. In fact, national-level differences are certain to remain, at the very least because of differences in the legal, regulatory, and industrial relations institutional environment that **will** persist at the national level. However, I am arguing that the value of using the "country" lens to understand changes in work organization is less and less, particularly during a time when various forces are promoting the diffusion of a new set of organizing principles. It may make sense to first examine company-level factors affecting the adoption and diffusion of new approaches to work organization, and then to turn to national-level explanations to explain residual variation. Conversely, the "country" lens will continue to be the best starting place for understanding those aspects of industrial relations not directly linked to product market strategies, e.g. mechanisms of worker representation, collective bargaining processes and outcomes, and union structure.

This brings us back to the issue of how changes in work organization will relate to national-level differences in industrial relations, which are likely to persist. European companies and unions, with an institutional structure that insures more union involvement in strategic decision-making, have shown a greater ability to make connections between the technical and the "people" aspects of work organization, both in their strategizing and in their day-to-day operations. The speed with which many European plants have moved towards "group work" and other new work practices may be evidence of capability for learning and flexible responsiveness to changing environmental conditions in the union-management relationship that has been less achievable in the U.S. Or there may simply have been a more clearly legitimized "model" for change in the early 1990s, when the most "unfreezing" took place for European companies and unions, than in the 1980s, a more turbulent period of transition that left both the Big Three and the UAW more ambivalent about work organization changes. In any case, the ongoing experiences of companies and unions in Europe, the NIC countries, and Australia -- the regions that have moved

substantially in the direction of flexible work practices -- will surely influence the relative mix of convergent and divergent trends in work organization by the year 2000.

References

- Adler, Paul S. 1992. "The 'Learning Bureaucracy': New United Motor Manufacturing, Inc." In Barry M. Staw and Larry L. Cummings, eds., Research in Organizational Behavior. Greenwich, CT: JAI Press.
- Adler, Paul S. and Robert E. Cole. 1993. "Designed to Learn: A Tale of Two Auto Plants", Sloan Management Review (Spring), pp. 33-45.
- Automotive Industry Authority. 1989. "Award Restructuring," Report of a Tripartite Study Mission to Japan, the United States, Germany, and Sweden. Melbourne, Australia.
- Automotive News Market Data Book, various years.
- Baron, James N., Frank Dobbin, and P. Devereaux Jennings. 1986. "War and peace: the evolution of modern personnel administration in U.S. industry," American Journal of Sociology 92: 350-83.
- Berggren, Christian. 1993. "Volvo Uddevalla -- a dead horse or a car dealer's dream?", working paper, Royal Institute of Technology, Stockholm.
- Berggren, Christian. 1992. Alternatives to Lean Production: Work Organization in the Swedish Auto Industry. Ithaca, NY: ILR Press.
- Brown, Claire and Michael Reich. 1989. "When Does Union-Management Cooperation Work? A Look at NUMMI and GM-Van Nuys." California Management Review, Vol. 31, No. 4 (Summer), pp. 26-44.
- Camuffo, Arnaldo and Giuseppe Volpato. 1994. "Labor Relations Heritage and Lean Manufacturing at Fiat," paper presented at "International Developments in Workplace Innovation" conference, Toronto.
- Camuffo, Arnaldo, and Stefano Micelli. 1995. "Mediterranean Lean Production? Supervisors, Teamwork, and New Forms of Work Organization in Three European Car Makers", paper for International Industrial Relations Association 10th World Congress, Washington, D.C.
- Cole, Robert. 1989. Strategies for Learning: Small Group Activities in Japanese, American, and Swedish Industry. Berkeley, CA: University of California Press.
- Cusumano, Michael. 1985. The Japanese Auto Industry: Technology and Management at Toyota and Nissan. Cambridge, MA: Harvard University Press.
- Cusumano, Michael. 1994. "The Limits of 'Lean', Sloan Management Review (Summer 1994), pp. 27-32.
- Department of Labor. 1991. Chrysler's Modern Operating Agreements. Report prepared by Malcolm Lovell and Susan Goldberg, George Washington University, and Robert McKersie, Thomas A. Kochan, John Paul MacDuffie, Larry Hunter, and Andrew Martin.
- Florida, Richard and Martin Kenney. 1991. "Transplanted Organizations: The Transfer of Japanese Industrial Organization to the U.S." American Sociological Review Vol. 56 (June), pp. 381-398.
- Fucini, J. and Fucini, J. 1990. Working for the Japanese: Inside Mazda's American Auto Plant. New York: Free Press.
- Kochan, Thomas A. and Peter Cappelli. 1984. "The Transformation of the Industrial Relations/Human Resources Function" in Osterman, Paul (ed.), Internal Labor Markets. Cambridge, MA: MIT Press.
- Nohria, Nitin and Carlos Garcia-Pont. 1991. "Global Strategic Linkages and Industry Structure," Strategic Management Journal 12: 105-124.

- Graham, Laurie. 1993. "Inside a Japanese Transplant: A Critical Perspective", Work and Occupations, Vol. 20, No. 2, pp. 147-173.
- Hancke, Robert. 1993. "Technological Change and its Institutional Constraints: The Politics of Production at Volvo Uddevalla," working paper #93-05, Science, Technology, and Public Policy Program, Kennedy School of Government, Harvard University.
- Huxley, Christopher, James Rinehart, and David Robertson. 1995. "Challenging Lean Production: Workers and their Union at a GM-Suzuki Transplant", paper for International Industrial Relations Association 10th World Congress, Washington, D.C.
- Jaikumar, Ramchandran (1986). "Post-Industrial Manufacturing", Harvard Business Review, Nov.-Dec. issue, pp. 69-76.
- Jürgens, Ulrich. 1995. "Volkswagen at the Turning Point: Success and Crisis of a German Production Concept", working paper, Actes du GERPISA #10.
- Jürgens, Ulrich, Thomas Malsch, and Knuth Dohse. 1993. Breaking from Taylorism: Changing Forms of Work in the Automobile Industry, Cambridge University Press.
- Katz, Harry C. 1993. "The Decentralization of Collective Bargaining: A Literature Review and Comparative Analysis," Industrial and Labor Relations Review, vol. 47, no. 1, pp. 3-22.
- Kogut, Bruce and Udo Zander. 1992. "Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology." Organization Science, Vol. 3, No. 3 (August), pp. 383-397.
- Krafcik, John F. 1988. "Comparative Analysis of Performance Indicators at World Auto Assembly Plants." Unpublished masters' thesis, Sloan School of Management, M.I.T.
- Krafcik, John F. and MacDuffie, John Paul (1989). "Explaining High Performance Manufacturing: The International Automotive Assembly Plant Study", Working Paper, International Motor Vehicle Program, M.I.T.
- Lansbury, Russell D. and Greg J. Bamber. 1995. "Making Cars in Australia: New Models of Work and Production," paper for International Industrial Relations Association 10th World Congress, Washington, D.C.
- Lewchuk, Wayne. 1988. American Technology and the British Car Industry. Cambridge, England: Cambridge University Press.
- Locke, Richard. 1992. "The Demise of the National Union in Italy: Lessons for Comparative Industrial Relations Theory", Industrial and Labor Relations Review 45, no. 2: 229-49.
- MacDuffie, John Paul. 1995a. "Human Resource Bundles and Manufacturing Performance: Organizational Logic and Flexible Production in the World Auto Industry," Industrial and Labor Relations Review, Vol. 48, No. 2 (January), pp. 192-221.
- MacDuffie, John Paul. 1995b. "The Transfer of Organizing Principles in the World Auto Industry: Cross-Cultural Influences on Replication Efforts," working paper, Wharton School, U. of Pennsylvania.
- MacDuffie, John Paul. 1991. "Beyond Mass Production: Flexible Production Systems and Manufacturing Performance in the World Auto Industry." Unpublished doctoral dissertation, Sloan School of Management, M.I.T.

MacDuffie, John Paul, Larry W. Hunter, and Lorna Doucet. 1995. "What does transformation mean to workers? The effects of the 'New Industrial Relations' on union employees' attitudes", presented at Academy of Management meetings, Vancouver.

MacDuffie, John Paul and Thomas A. Kochan. 1995. "Do U.S. Firms Underinvest in Human Resources? Determinants of Training in the World Auto Industry", Industrial Relations, vol. 34, no. 2, pp. 147-168.

MacDuffie, John Paul, Kannan Sethuraman, and Marshall L. Fisher. 1996. "Product Variety and Manufacturing Performance: Evidence from the International Automotive Assembly Plant Study", forthcoming in Management Science.

MacDuffie, John Paul and John F. Krafcik. 1992. "Integrating Technology and Human Resources for High Performance Manufacturing." In Transforming Organizations, edited by Thomas A. Kochan and Michael Useem, pp. 209-225. New York: Oxford University Press.

MacDuffie, John Paul and Frits K. Pil. 1994. "Transferring Japanese Human Resource Practices: Japanese Auto Plants in Japan and the U.S.", presented at Academy of Management meetings, Dallas, Texas.

MacDuffie, John Paul and Frits Pil (1995). "'High Involvement' Work Systems and Manufacturing Performance: The Diffusion of Lean Production in the World Auto Industry," working paper, Wharton School, U. of Pennsylvania.

Monden, Yasuhiro. 1983. Toyota Production System. Norcross, GA: Institute of Industrial Engineers.

Ono, Taiichi. 1988. Workplace Management. Cambridge, MA: Productivity Press.

Roth, Siegfried. 1995. "Rediscovering its own strength? Lean production in the German automobile industry," paper for International Industrial Relations Association 10th World Congress, Washington, D.C.

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

Shimada, Haruo and John Paul MacDuffie. 1987. "Industrial Relations and 'Humanware': Japanese Investments in Automobile Manufacturing in the United States." Working Paper, Sloan School of Management, M.I.T.

Turner, Lowell. 1991. Democracy at Work: Changing World Markets and the Future of Labor Unions. Ithaca, NY: Cornell University Press.

Westney, Eleanor. 1987. Imitation and Innovation. Cambridge, MA: Harvard University Press.

Womack, James, Daniel Jones and Daniel Roos. 1990. The Machine That Changed the World. New York: Rawson-MacMillan.

Table 1
Factors Leading to Divergence Across Companies

Company	Timing of Crisis	Perceived Path to Competitiveness	Mgmt. strategy for Work Org. Change	Union response to Work Org. Change	Past experience w/ Work Innovations	Capabilities for External Learning
GM - U.S.	early 1990s	"high tech" (80s) cost-cutting (90s)	QWL and teams Synchronous Mfg. and Quality Network resp. into line jobs; off-line EI groups	Supportive in early 80s; Mixed to negative in late 80s	Scattered efforts discredited in eyes of mgmt., union (90s)	Low - unable to learn much from NUMMI or Saturn
Ford - U.S.	early 1980s	quality; employee involvement (80s) "world car" (90s)	MOA (teams, new pay systems) at some; POA (reduced job classes) at others	Mostly supportive	Cautious about teams due to GM experience	Mod. to high - work effectively with Mazda and Nissan
Chrysler	early 1980s early 1990s	cost-cutting (80s) new products (90s)		Mixed for MOA; Not involved in POA	None	Moderate - learned some from Mitsubishi more from Honda; less in mft. than PD
GM - Europe	early 1980s	cost-cutting (80s) lean production (90s)	off-line subassembly (80s); teams (90s)	Supportive but feel scope of change is too broad	Influenced by Volvo, VW problems	High - able to learn from NUMMI, CAMI
Ford - Europe	early 1980s	cost-cutting, quality (80s); "world car" (90s)	Integrating quality resp. into line jobs;	Supportive, except in UK	Follows cautious lead of Ford U.S.	Moderate - able to learn from Ford U.S., Mazda
Volkswagen	mid-1970s early 1990s	"high tech" (80s) "lean production" (90s)	off-line subassembly, skilled workers run high-tech areas (80s); cost-cutting (90s)	Supportive	Off-line efforts influenced by Volvo experiments	Low - few alliances, see themselves as innovators; no need to learn seen pre-90s
Volvo	mid-1970s early-1990s	"socio-tech" plants (80s); "lean production" (90s)	autonomous teams; off-line subassembly; Uddevalla w/ no line	Supportive	Each experiment seen as partial, next one goes further	Low - few alliances, see themselves as innovators; no need to learn seen pre-90s
Renault	mid-1980s	lean production	teams	Adversary pre-crisis; then supportive	None	High - able to learn about lean production
Fiat	mid-1970s early 1990s	"high tech" (80s) lean production (90s)	teams	Adversary pre-crisis; then supportive	None	Mod. to high - able to learn about LP

Table 2a
Regional Averages for Work Organization Variables -- Round 1 (1989) vs. Round 2 (1993/94)
Matched and Unmatched Samples

Variable	Jpn/Jpn 1989 93/94	Jpn/N. A. 1989 93/94	U.S./N. A. 1989 93/94	A. US&E/Eur. 1989 93/94	NIC 1989 93/94	Aust. 1989 93/94						
Matched Sample (n=38)												
% Workforce in Teams	78%	70%	71%	76%	10%	6%	0.4%	75%	2%	30%	0	34%
% Workforce in EI Groups	93%	90%	12%	14%	17%	20%	5%	54%	42%	68%	24%	62%
Job Rotation (0=none; 4=lots)	3.8	4.2	2.7	3.7	0.9	2.1	1.8	3.9	2.2	3.7	1.7	3.7
Suggestions per Employee	56	48	1.1	1.9	0.3	0.2	0.3	1.0	2.3	???	0.1	0.2
% Suggestions Implemented	91%	90%	68%	79%	22%	34%	15%	49%	39%	59%	8%	6%
Work Systems Index	82.1	80.8	49.1	50.7	22.5	24.0	16.0	52.6	36.8	55.4	19.7	36.4

Unmatched Samples (n=62 and n=81)												
% Workforce in Teams	84%	70%	78%	72%	12%	18%	0.5%	62%	3%	37%	13%	49%
% Workforce in EI Groups	100%	81%	13%	25%	21%	26%	11%	49%	31%	73%	16%	51%
Job Rotation (0=none; 4=lots)	3.1	3.9	2.7	3.9	0.9	2.0	1.7	3.6	2.0	3.2	1.7	4.0
Suggestions per Employee	61	51	1.0	3.6	0.3	0.3	0.4	0.9	1.4	???	0.1	0.2
% Suggestions Implemented	88%	84%	61%	65%	22%	41%	23%	41%	32%	48%	20%	23%
Work Systems Index	77.9	78.9	47.3	50.4	22.6	28.1	24.1	46.7	27.9	57.3	19.4	43.5

Table 2b
Regional Averages for Production Organization Indices, Technology, and Product Variety Variables
Round 1 (1989) vs. Round 2 (1993/94) -- Matched and Unmatched Samples

Variable	Jpn/Jpn	Jpn/N. A.	U.S./N. A.	A. US&E/Eur.	NIC	Aust.						
Matched Sample (n=38)	1989	93/94	1989	93/94	1989	93/94						
Total Automation	38%	36%	35%	38%	34%	35%	26%	32%	13%	17%	9%	8%
Robotic Index	3.9	7.4	4.2	5.7	2.4	2.5	2.4	3.9	1.0	2.3	0.6	0.6

Model Mix Complexity	52.0	44.9	14.0	15.9	19.3	18.2	37.0	27.9	48.0	35.3	18.2	42.2
Parts Complexity	71.5	39.7	33.0	8.2	42.3	18.7	74.9	22.6	50.7	20.8	22.6	11.0

Use of Buffers Index	96.0	83.7	77.4	76.2	65.3	66.6	51.0	68.8	71.1	70.6	66.4	44.4
HRM Policies Index	63.2	55.5	65.1	68.5	31.5	35.6	38.1	58.9	47.7	51.7	14.6	62.3
Work Systems Index	82.1	80.8	49.1	50.7	22.5	24.0	16.0	52.6	36.8	55.4	19.7	36.4
Unmatched Samples (n=62 and n=81)												
Total Automation	38%	35%	36%	38%	30%	34%	26%	31%	8%	21%	10%	9%
Robotic Index	4.4	6.3	4.6	6.5	2.2	3.3	2.2	3.4	0.6	3.2	0.5	0.7

Number of Models Produced*	5.1	5.4	1.9	2.3	2.7	2.2	2.6	2.5	2.8	3.0	4.0	4.0
Number of Countries For Export*	6.9	16.7	23.6	26.6	2.9	5.6	23.7	26.6	38.9	51.4	1.5	2.3
Wire Harnesses*	430	580	35	37	15	12	83	84	39	61	8	8
Exterior Colors*	24	33	12	14	10	11	15	16	12	14	10	10
Engine/Trans. Combinations*	180	167	52	63	30	29	83	86	77	???	11	15
(* = data are from 1990 and 1993/94)												

Use of Buffers Index	93.1	79.3	79.6	70.8	59.0	66.6	54.1	67.9	61.9	49.6	68.3	25.3
HRM Policies Index	56.0	52.4	67.3	75.3	30.6	41.9	31.1	57.6	35.9	48.3	18.2	62.6
Work Systems Index	77.9	78.9	47.3	50.4	22.6	28.1	24.1	46.7	27.9	57.3	19.4	43.5

Table 3
Company and Regional Comparisons of Means for key Variables (1993-1994 Data)

Variable	Firm A-U.S.	Firm A-Europe	Firm B-U.S.	Firm B-Europe	Firm C-U.S.	Firm C-Europe
% Total Automation	37	32	31	29	35	38
Robotic Index	3.6	3.7	1.9	2.8	4.5	6.8
Use of Buffers	68	77	43	62	87	93
HRM Policies	35	48	34	43	79	NA
Work Systems	35	60	15	33	56	86

NA = Insufficient Data

Table 4
T-tests for Company and Regional Means for Key Variables -- 1993/94 Data

Variable	Comparison of Mean			Comparison of Mean			
	Within-Company, Across Region			Across-Company, Within Region			
	Firm A-U.S.	Firm B-U.S.	Firm C-U.S.	Firm B-U.S.	Firm B-U.S.	Firm A-U.S.	Firm A-Europe
	vs.	vs.	vs.	vs.	vs.	vs.	vs.
Firm A-Europe	Firm B-Europe	Firm C-Europe	Firm A-U.S.	Firm C-U.S.	Firm C-U.S.	Firm C-Europe	
Productivity	•••	—	—	•••	—	•••	••
Quality	NA	NA	—	—	•	••	NA
Total	—	—	—	—	—	—	—
Automation							
Robotic Index	—	••	—	•	••	—	—
Use of Buffers	—	—	—	••	••	••	••
HRM Policies	—	—	—	—	•••	•••	—
Work Systems	•••	•	••	••	•••	••	••

••• t-test is significant at $p < .01$

•• t-test is significant at $p < .05$

• t-test is significant at $p < .1.0$

— t-test is not statistically significant

NA insufficient data to do t-test

ENDNOTES

¹ One note about the assessment of convergence or divergence is in order here. Both convergence and divergence are dynamic processes of change that must be assessed within some frame of reference that captures both time frame and assumptions about the feasible rate of change. If one assumes that change in the direction of some well-understood "best practice" should occur quickly, then anything less than full convergence upon such practice in a reasonable period of time could be taken as evidence of partial or unsuccessful diffusion. Yet most available literature (e.g. Kochan and Useem, 1992) would suggest that change within organizations is inherently slow and that the key traits that underlie some example of "best practice" are rarely well understood before they are transferred into other organizational settings (e.g. Kogut and Parkinson, 1991). From this perspective, even modest movement towards a new production model across a range of companies and countries and within a relatively short period of time could be taken as impressive evidence of convergence.

² For example, workers can easily do minor reprogramming of weld robots (where allowed to do so) by physically "teaching" the robot where the new weld spot should go by moving the weld tip to the exact spot. This removes the technical barriers to incremental changes in weld placement -- unlike fixed automation, where any changes require engineering involvement and substantial cost.

³ The causality is not clear in the link between flexible technology and flexible work organization. Although the acquisition of flexible technology may in some cases be "pulled" by earlier changes in work organization, they may also "push" changes in work organization in order to gain maximal value from the capital investment.

⁴ Ironically, this is a time when a prolonged recession in the Japanese industry, the apparent end to years of uninterrupted growth, and various problems (e.g. traffic congestion from Just-in-Time deliveries, difficulty attracting young Japanese to factory work, going overboard on product variety) are giving rise to new questioning of lean production in Japan (Cusumano, 1993). While this has sounded a cautionary note for U.S. and European companies, it does not appear to have weakened their perception that they can benefit from moving towards lean production.

⁵ There are also a number of factors that promote divergence in work practices within companies, including "greenfield" vs. "brownfield" facilities, the strength of market demand for the products made in a particular plant, and plant-specific arrangements with competing companies for collaborative "benchmarking" or joint venture production. Companies typically use new "greenfield" sites for the most comprehensive changes in work practices. In older plants, the management philosophy at many companies is to attempt major changes in work practices only when there will be an "significant emotional event" (GM's term) -- generally a corporate decision about investment and product placement -- that will shake up employees and ready them for change. Such management pressure is unlikely to be applied at a plant that is building a best-selling product and running at or above full capacity, given the risk of disrupting both economies of scale and profitability with an unwelcome initiative to change work practices. For example, Chrysler plants making the minivan have regularly been able to resist pressure from both top management and the Chrysler department of the UAW to adopt an MOA contract. Finally, it appears that plants engaged in benchmarking comparisons inside and outside their company -- an increasingly common phenomenon -- are often more willing to share information with a competitor's plant than with a plant within their own company, due to internal company rivalries over resources (including investment, promotion opportunities, the chance to hire new employees). This situation may contribute to both convergence across companies and divergence within companies in work practices.

⁶ In the German context, many of those involved in the debates over new forms of work organization differentiate between "group work" and "team work". The former term is associated with high autonomy from both managerial oversight (i.e. "self-managing" with no supervisor) and technical constraints (i.e. a machine-paced assembly line), in the tradition of socio-technical theory and many Scandinavian experiments, while the latter term is associated with Japanese-style lean production and is characterized as low in autonomy and dominated by management. These distinctions are less often observed in practice, in part because many companies choose to create their own unique term for their group/team-based activities (e.g. "elementary technical units" at Fiat, "work modules" at Saturn).

⁷ See MacDuffie 1995a for more information on the construction of the Work Systems Index and other production organization indices.

⁸ For the U.S. plants, it is worth noting that the unmatched sample shows a more substantial increase in the percentage of employees affected by small group activities (from 12% to 19% for work teams and from 21% to 29% for employee involvement or problem-solving groups) than the matched sample (a drop from 10% to 6% for work teams and a smaller increase, from 17% to 20%, for employee involvement groups). This is because some traditional plants in the 1989 sample have closed and the new plants in the Round 2 sample make more use of such small group activities.

⁹ The reduction in the level of some of these practices in Japan is not substantial enough at this point to be judged as a move away from the “lean production” principles of work organization, particularly since these modifications may represent an adjustment to recession. However, future trends in Japan bear watching closely for evidence of further shifts, either towards traditional mass production practices or in some new direction.

¹⁰ Japanese plants have had flexible work organization much longer than they have had programmable automation, suggesting that the former helped make investments in the latter more feasible and/or cost-effective.

¹¹ For the U.S. plants, comparing the matched and unmatched samples provides one important insight. For the matched sample, the increase in the Robotic Index for the U.S. plants is negligible, as is the change in their use of flexible work practices. Yet for the unmatched sample, a larger change for both automation and flexible work practices is reported. This suggests that Big Three plants in the matched sample are more traditionally “mass production” in orientation than the unmatched sample for 1993/94, which includes some new plants that are more oriented towards flexibility in both areas. Still, even for the unmatched U.S. sample, the increase in flexible work practices is much less, compared to Europe, in relation to a similar increase in flexible automation across the two regions

¹² Given that these questions about product variety concern physical characteristics of the products made in each plant, the 1990 data are unlikely to be affected by any retrospective bias.

¹³ Data on the number of platforms at each plant, the most fundamental indicator of product variety (since multiple models can be built from the same platform), are not included here because of definitional problems that make the data difficult to interpret.

¹⁴ It should be noted that after 1993, Japanese companies also made concerted efforts to reduce the number of models and other aspects of product variety, which were perceived as getting out of hand, with negative consequences for company cost structures. This caveat applies to all the complexity measures discussed here.

¹⁵ I have made a similar argument about the discrepancy, during much of the 1980s, between the high levels of training and education for the workforce in many European plants and their traditional work organization practices (MacDuffie and Kochan, 1995).

¹⁶ For example, wire harnesses provide the infrastructure for electrical options, so as products offer more sophisticated audio systems, more power accessories (windows, locks, seats), and fancier electronic engine regulation and environmental controls, the number of harnesses proliferates. Different export markets often regulate electrical equipment differently, so more export markets typically means more different wire harnesses. The increase in exterior colors to please consumers doesn't pose many problems for the paint shop but does have a cascading effect on the number of color-dependent trim parts (e.g. bumpers, mirrors, interior upholstery and other decoration) that must be unpacked, delivered, and organized for easy and reliable installation. The more different engine and transmissions are offered to consumers, the more possible combinations must be scheduled and planned logistically.

¹⁷ The amazingly high numbers of wire harnesses and engine/transmission combinations for plants in Japan are due in part to different design principles for wire harnesses and a different definition of engine variants, as well as the very high number of different export markets.

¹⁸ These scores must also be interpreted with some caution. Australian colleagues have told us that these answers reflect the **plans** for compensation and training that are required in the new agreement, not necessarily what has yet been implemented.

Due to confidentiality agreements, I cannot elaborate on these company differences here.