

Designed for Learning: A Tale of Two Auto Plants

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THE TOYOTA-GM JOINT VENTURE, NUMMI, AND VOLVO'S UDDEVALLA PLANT REPRESENT TWO DIFFERENT WAYS OF ORGANIZING THE labor-intensive production of standardized products, in this case, auto assembly. NUMMI is based on the Japanese "lean production" model, whereas Uddevalla has been called a "human-centered" model. Which model can best stimulate continuous improvement while maintaining worker morale? The authors argue that the answer is, emphatically, NUMMI. ‡

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A consensus is emerging that the hallmark of tomorrow's most effective organizations will be their capacity to learn. To survive in the competitive turbulence that is engulfing a growing number of industries, firms will need to pinpoint innovative practices rapidly, to communicate them to their employees and suppliers, and to stimulate further innovation.

However, there are two very different views on the organizational design most effective to support learning, particularly in labor-intensive production of relatively standardized products.¹ Proponents of the Japanese-inspired "lean production" model, such as the MIT researchers who contributed to *The Machine That Changed the World*, argue that organizational learning will be maximized in a system based on specialized work tasks supplemented by modest doses of job rotation and great discipline in the definition and implementation of detailed work procedures.² By contrast, European managers, union officials, and academics are engaged in a lively discussion on the possibility of a German-Scandinavian alternative.³ Proponents of this "human-centered" model argue that organizational adaptability and learning is best served by greatly lengthened work cycles and a return to craftlike work forms that give teams substantial latitude in how they perform their tasks and authority over what have traditionally been higher-level management decisions.

Toyota is often credited with pioneering the key elements of the lean production model. In the United States, the best documented of Toyota's plants is the Toyota-General Motors (GM) joint venture, the New United Motor Manufacturing, Inc. (NUMMI) plant in California. Volvo's Uddevalla plant exemplifies the human-centered alternative. It is one of Volvo's most innovative plants, radically extending the long-cycle and team autonomy concepts that shaped the famous Kalmar plant.⁴

In November 1992, Volvo announced that it would close the Uddevalla and Kalmar plants, but these plant closings should not close the debate over the significance of their innovations. The two plants are not being shut down due to poor performance. In fact, Kalmar operated at productivity and quality levels higher than those at Volvo's main Torslanda plant, and Uddevalla was already matching Torslanda in productivity. However, Volvo was operating at very low capacity utilization levels, and managers believed that shutting down the two smaller plants was an effective way to reduce total overhead. Although Volvo's innovations in work organization will continue in some of its truck and component plants, the closing of these two plants will end a remarkable twenty-five year period in which Volvo's efforts to humanize and democratize work inspired managers, union officials, and academics around the world. The concept of self-

managing teams so popular in the United States today owes much to these two plants, as does the design of GM's Saturn plant. Whether the advocates of work reorganization within Volvo will be able to refocus their efforts on reforming Volvo's other facilities remains to be seen. Whatever the case, there is much to be learned from the Kalmar and Uddevalla experience.

Between us, we have studied firsthand a number of Toyota's Japanese plants, the NUMMI facility, and several Volvo facilities, including Uddevalla. In this article, we

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assess the relative merits of NUMMI and Uddevalla as organizations designed to support learning. In brief, we argue that, although elements of the Uddevalla approach do indeed promise a higher potential for *individual* learning, NUMMI is the more effective model for encouraging *organizational* learning. The NUMMI model thus assures a higher growth rate for productivity and manufacturing quality. Proponents of the Uddevalla model argue that the NUMMI model's purported technical strengths will be overshadowed by its lack of opportunities for personal development and that its regimentation will undercut worker motivation. We believe that this critique is misconceived and that the intense discipline created by NUMMI's job design creates not only world-class performance but also a highly motivating work environment.

First, we describe some of the key aspects of the two plants' organizational designs. Then, we compare their performance results and identify some technical factors that may contribute to these results. Finally, we closely examine the social factors and critique some popular misapprehensions about the sources of motivation and of organizational learning.

Comparing Organizational Designs

NUMMI and Uddevalla are similar in several important respects. They are both truly committed to treating employees as their most important assets and to providing opportunities for employee growth. For both plants, governance is accomplished by a relatively strong part-

nership between union and management. Finally, they are both organized around production teams.

But the similarities give way to important differences when we examine the internal organizations more closely. The NUMMI and Uddevalla production teams are very different. At NUMMI, teams are composed of four or five workers under a team leader, and both team members and team leaders are hourly workers. Each team member performs a work cycle of about sixty seconds. In the final assembly department, the teams are linked in series, in a traditional "Fordist" assembly line pattern. Toyota's just-in-time inventory system ensures that this interdependence is very taut. Teams take on responsibilities not normally the province of line workers in U.S. auto plants, in particular for quality assurance, preventive maintenance, and internal job rotation schedules. They also define work methods and standards, but must satisfy managers and engineers that these methods and standards are optimal and that they are implemented identically across workers and shifts. Although such worker involvement in defining methods violates Frederick Taylor's principles of "scientific management," the resulting job designs are very Tayloristic in their narrow scope and gesture-by-gesture regimentation.

At Uddevalla, the break with Taylorism and Fordism was deliberate and radical. The plant's model evolved at a time when Volvo was experiencing a production capacity bottleneck in a protected market with no efficient Japanese competitors for its niche. In the mid-1980s, Volvo was selling everything it could make, and lack of productive capacity was the problem. The major constraint in breaking the capacity bottleneck was the tight Swedish labor market. The design of the Uddevalla plant was labor-market driven, not product-market driven. As one of the key managers involved in the plant design expressed it, "The problem we had was how could we make the plant attractive for Swedish workers to want to work in it."

In the newly designed plant, each of eight production teams took full responsibility for assembling the vehicle from the subsystems up — a work cycle of about two hours. The plant abolished the assembly line, as the eight teams worked in parallel. The teams were larger, ten people as opposed to four or five at NUMMI, and they had much broader responsibilities than at NUMMI. Because the work cycle was so long, Uddevalla teams paid much less attention than NUMMI teams to detailed, gesture-by-gesture standardization and instead focused on the more aggregated balance of tasks within the whole assembly cycle. Not only did Uddevalla teams decide job rotation schedules, they also selected their own hires and

decided on their own overtime schedules. At NUMMI, union representatives and managers jointly select team leaders based on objective tests, whereas at Uddevalla, teams selected their own leaders and often rotated the role.

Both organizations put great stock in worker training. NUMMI has invested considerable time and effort in training workers in the principles and techniques of its production system, but it offers no pay premium for the accumulation of new skills. At Uddevalla, team members' pay increased with the accumulation of proved expertise.

Comparing Performance Results

NUMMI took over the old GM plant in Fremont and hired about 85 percent of its workforce from the ranks of laid-off GM-Fremont workers. Pilot production began in December 1984, and by 1986, NUMMI was almost as productive as its sister Toyota plant in Takaoka and more productive than any other GM plant. Total hourly and salaried hours per vehicle averaged 20.8 at NUMMI in 1986, as opposed to 18.0 in Takaoka, 40.7 in the relatively comparable GM-Framingham plant, and 43.1 at the old GM-Fremont plant in 1978. Inventory levels averaged two days, which was significantly below U.S. auto industry averages, but still above the two-hour level prevailing in Takaoka, primarily due to difficulties in running true just-in-time inventory with suppliers in Japan and the U.S. midwest.⁵

More recent data indicate that this extraordinary performance was not merely a honeymoon phenomenon. According to a J.D. Power and Associates study of the number of problems per 100 vehicles experienced by customers within ninety days of purchase, NUMMI scored 116 in 1989, compared to an industry average of 148 for all cars sold in the United States. The number of problems went up in 1990 with the introduction of Geo Prizm and new domestic suppliers but then decreased to 93 in 1991 and to 83 in 1992 (when the industry average was 125 for all cars sold in the United States and the average for Asian nameplates was 105; for U.S. nameplates, 136; and for Europeans, 158).⁶

What of NUMMI's quality of worklife? Here, too, the indicators are very impressive:

- Absenteeism has held steady at about 3 percent.
- Participation in the suggestion program had increased to over 90 percent by 1991, and workers made over 10,000 suggestions that year, an average of about 5 suggestions per worker. The implementation rate for these suggestions was over 80 percent, which reflects as much

or more on NUMMI's policy of encouraging involvement as on the quality of the suggestions themselves.

- Internal surveys of worker attitudes showed that the overall proportion of people describing themselves as satisfied or very satisfied with their job at NUMMI had increased from 76 percent in 1987 to 85 percent in 1989 to 90 percent in 1991.

How does this compare with the Uddevalla plant? Unfortunately, the data here are sketchy:

- According to a *New York Times* article, it took fifty hours to assemble a vehicle at Uddevalla as opposed to an average of twenty-two hours for Japanese plants in the United States.⁷ When we visited the plant in the summer of 1991, the plant manager claimed that these data were old and that the plant had already reached the productivity of the Torslanda plant, which this *Times* article estimated at forty hours per vehicle. Even adjusting for the larger size of the vehicles produced at Uddevalla, the productivity differential would be substantial. (Unfortunately, we have no comparable quality data on Uddevalla's output.)

- Although absenteeism was half that of Volvo's main plant at Torslanda, it was still very high: sick leave absences averaged about 12 percent in 1990 and long-term disability about 10 percent, for a total of about 22 percent, compared to 3 percent absenteeism at NUMMI. Uddevalla workers benefited from much more generous sick leave provisions, and it is possible that NUMMI's strictness on absenteeism does not allow workers sufficient flexibility to balance work- and non-worklife. It is

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nevertheless clear that Uddevalla's worklife did not provide sufficient intrinsic satisfaction to overcome the long-standing Swedish tradition of high absenteeism rates.

- Turnover was high during Uddevalla's startup because some workers without industrial work experience did not accommodate to the pressures of the very demanding work in auto assembly. However, turnover settled at about 6 percent by 1991. This figure is comparable to NUMMI's, but turnover, like absenteeism, is influenced by many factors outside the plant's control.
- More telling, perhaps, was a 1992 survey of worker

satisfaction across Volvo plants, which revealed that Uddevalla scored in a similar range to the very traditional Torslanda plant. This was a big disappointment to management, which could only argue that it was the reflection of the workers' high expectations. This argument has some merit, but such a score also suggests that craft-style production may have been idealized by Uddevalla's designers and oversold as a cure to the ills of modern labor.

Perhaps we too have succumbed to this idealized view because we think that Uddevalla, not NUMMI, would be the more desirable place to work. Uddevalla offers a much less regimented environment, more task variety, more autonomy, and a lot more team self-management. However, there is little doubt as to which production system is capable of delivering the greatest efficiency and quality: it is NUMMI.⁸ In fact, one Volvo executive we interviewed stated flatly that Uddevalla would not have been built under today's circumstances, and it would be hard to find others at Volvo who would disagree. The context that produced Uddevalla has changed. The labor bottleneck has disappeared and efficient Japanese competitors are hurting Volvo in its export markets.

The question remains, Is the technical and economic superiority of the NUMMI system achieved at the expense of workers' well-being?

Interpreting the Results: Some Methodological Difficulties

Critics of the lean production system argue that it does not provide a viable model for production organization. Two variants of the criticism have been articulated. One line of criticism argues that, in the lean system, workers are forced to work under excessive stress.⁹ As a result, their motivation to ensure world-class quality and their participation in the *kaizen* (continuous improvement) process will eventually taper off, and the potential benefits of standardized, narrow jobs will be outweighed by the costs of worker disaffection. An alternative hypothesis assumes that workers will continue to participate in *kaizen* efforts frequently enough to ensure its productive superiority, but they will do so only out of fear of losing their jobs. Thus their bodies and minds are put under excessive stress, and many workers will quit their jobs exhausted after a few years, leaving society to pay the costs of this premature depreciation of our human resources.

Some observers have presented *prima facie* evidence for one or the other of these scenarios and jump to the

conclusion that NUMMI's production system is just a new way of further intensifying work effort, a form of ultra Taylorism.¹⁰ Kamata's description of his experience as a temporary worker in Toyota City in the early 1970s and Fucini and Fucini's description of the Mazda Flat Rock plant, for example, are cited as evidence supporting this characterization.¹¹ Parker and Slaughter have compiled an impressive dossier on the stress experienced by workers in some team concept plants.¹²

But it is not easy to draw strong conclusions from the anecdotal evidence available. Public debate and scholarly research both confront a number of methodological challenges in sorting out the relative merits of the alternative systems. First, many conceptions of the stressful, ergonomically unsound Japanese factory are based on old descriptions and images. In a recent systematic comparison of the Japanese and American auto industries, Richard Wokutch concluded that in spite of several significant weaknesses, safety and health conditions and practices in *large* Japanese auto firms were superior in many important respects to those in comparable American firms.¹³

Second, not all Japanese plants and transplants are identical. We should not assume that a practice found at one can be extrapolated to all. We should not assume that "good practices" at NUMMI are necessarily representative of all transplants or for that matter that they are even representative of all Toyota plants. A good case can be made that the Japanese have been forced to modify the harsher aspects of their production system to make them more compatible with the expectations of Western workers. In this article, we focus on the NUMMI version of the Japanese production model.

Third, problems observed at a plant at a given point in time may not be inherent in the underlying model. For example, Uddevalla experienced a high rate of turnover during its startup, but this was for reasons that are largely unrelated to the central debate. A fair assessment should assume that both approaches are capable of learning and evolution.

Fourth, it is important to avoid the frequent polemic device of shifting the point of comparison. From the worker's perspective, production systems at Japanese transplants like NUMMI are far from ideal, but the ideal is a rather remote comparison point, and we need to use realistic comparison points to make reasonable assessments.

Finally, if the debate is over the merits of alternative production system designs, we should filter out as much as possible other, unrelated aspects of management. Some Japanese transplants, for example, have been criti-

cized for discriminatory employment practices and for the difficult relations between U.S. managers and Japanese shadow managers.¹⁴ These management problems are often real and serious, but an alternative explanation is that these problems are symptomatic of Japanese firms' inexperience in international operations.¹⁵ Some of these practices do indeed appear racist, but it is certainly racist to assume that they are inherent features of Japanese management.

Interpreting the Results: Technical Aspects

To what then is NUMMI's productive superiority due? In particular, can this superiority be attributed to excessive stress imposed on workers? Our research suggests that the primary factor is NUMMI's effort to constantly improve the details of the production process. Such constant improvement is the key to productivity and quality in a product as standardized as an automobile. This constant improvement effort creates a certain level of stress, but as the worker attitude surveys show, the level is not so high as to degenerate into strain and distress.

Workers at both NUMMI and Uddevalla were encouraged to seek out improvements. And to help them, both groups received feedback on their task performance over their respective work cycles. But Toyota's standardized work system makes this feedback far more effective in sustaining improvement. At NUMMI, the work cycle is about sixty seconds long, and performance of the cycle is very standardized. Therefore, it is easy to identify problems, define improvement opportunities, and implement improved processes.

Uddevalla workers, too, had detailed information on their work cycle performance, but as this cycle was some two hours long, they had no way to track their task performance at a more detailed level. This problem was exacerbated by the craft model of work organization that encouraged Uddevalla workers to believe that they should have considerable latitude in how they performed each cycle.

Some proponents of the Uddevalla design principles argue that it offers a way around the line-balancing problems that limit the efficiency of traditional sequential assembly lines.¹⁶ But NUMMI effectively resolves those problems through a combination of modest doses of worker flexibility (far less extensive than Uddevalla's) and aggressive efforts to reduce set-up times. The standardization of detailed work methods facilitates efforts to reduce set-up times. Moreover, as the variety of models produced in a given plant increases, it becomes increasingly difficult for workers to recall the right proce-

cedure for each job, and shorter cycle times with well-defined methods help assure quality. As a result, NUMMI's assembly line can handle a relatively broad range of product types with minimal disruption.

Could the semiautonomous work teams at Uddevalla have come to see shorter work cycles and formalized methods as a better way and adopted it autonomously? Although Uddevalla had a bonus system that encouraged work teams to improve performance continually, the teams had neither the focus on the kinds of microscopic *kaizen* opportunities that drive NUMMI performance (because of Uddevalla's long work cycle) nor the tools to capture these opportunities (because they lacked standardized work processes). To the contrary, in fall 1991, we were informed that there was no detailed doc-

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umentation available to workers describing how to perform each work task and specifying how long it should take. One of the Uddevalla workers we interviewed argued, "You don't really need all that detail because you can feel it when the task isn't going right; you can feel the sticking points yourself." But workers at Uddevalla had no mechanism for identifying, testing, or diffusing the improvements that individual workers might make to eliminate these sticking points. The engineering staff from different work areas met to share new ideas. But without a well-documented, standardized process, it is hard to imagine how these people could have spotted improvement opportunities or shared them across the teams. You cannot sustain continual improvement in the production of products as standardized as automobiles without clear and detailed methods and standards.

Interpreting the Results: Human Aspects

The key points of contention in the debate over the human aspects of the competing models are work design and the broader plant governance process. Let us compare NUMMI and Uddevalla on these dimensions.

NUMMI's work organization follows what we have called the "democratic Taylorism" model.¹⁷ As Frederick Taylor and modern industrial engineering practice recommend, jobs are specialized and work processes are

standardized to the extent justified by the repetitiveness of the production task. But unlike traditional "despotic Taylorism," NUMMI's methods and standards are not designed to squeeze more work out of employees that management assumes are recalcitrant and irresponsible. Instead, these methods and standards are determined by work teams themselves: workers are taught how to time their own jobs with a stopwatch, compare alternative procedures to determine the most efficient one, document the standard procedure to ensure that everyone

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can understand and implement it, and identify and propose improvements in that procedure. At any given time, the task of standardized work analysis might be delegated to a team leader or a team member, but everyone understands the analysis process and can participate in it.

At Uddevalla, work teams were left to their own devices. In the very early days of Uddevalla, managers gave workers the procedure documents from the Torslanda plant. But these procedures were not very well designed, as Torslanda is a traditional plant where workers play no role in defining procedures. As a result, the Uddevalla workers quickly discarded them and, along with them, the very idea of detailed methods and standards. In auto assembly operations, where competitiveness hinges so greatly on efficiency and manufacturing quality, this management philosophy sounds more like abandonment than empowerment.

There is one aspect of work design where we believe Uddevalla had the edge over NUMMI. Uddevalla's "pay for knowledge" system provided substantial incentives for workers to build a deeper and broader knowledge base. The United Auto Workers (UAW) contract at NUMMI does not allow such individualized pay systems. But here NUMMI is behind the practices of Japanese assembly plants, which have an elaborate system of skill grades as well as individual merit evaluations.¹⁸ These evaluations (*satei*) have been characterized by critics as a manipulative tool of management control.¹⁹ Indeed, in the absence of a strong union, such manipulative use seems likely, and there is indeed evidence of such use in Japan. But if management wants

workers to contribute innovative ideas — to act as knowledge workers — then reward systems will need to be redesigned to look more like those used for knowledge workers, such as the skill-and-merit systems typically used to reward engineers.²⁰ Clearly, if these systems are to be successful, they will need to be implemented with the careful attention to equity that managers usually show in dealing with knowledge workers.

The second key dimension of comparison is at the plant governance level. Uddevalla had a democratic form of plant governance in which the union played a strong role in shaping the plant's design and operating policies.²¹ NUMMI, too, has relatively democratic plant governance. The union actively participates in a broad range of policy decisions that were previously closely guarded management prerogatives. Union and management representatives jointly investigate all problems; management has committed to advance consultation with the union on layoffs, schedule changes, and major investments; and management and the union jointly review any unusual or mitigating circumstances before employees are discharged or suspended. When workers objected to favoritism in the selection of team leaders, the union negotiated a selection process with an explicit set of criteria and a joint union-management selection committee.

Critics of NUMMI's system argue that the absence of firm, explicit contract language and the extent of informal, cooperative problem solving at NUMMI are symptomatic of a degeneration into "company unionism." We argue, to the contrary, that any democratization of plant governance inevitably must draw the union into greater partnership, and the Local leadership's effectiveness in representing worker interests in this new setting depends on management's commitment to cooperation as well as on the Local leaders' skills, the level of internal Local democracy, and the resources and guidance provided by the International. NUMMI's record in these areas is certainly not flawless, but nevertheless justifies strong optimism.²²

But the critics' concerns can then be restated: Can the NUMMI model, with the corresponding UAW influence and involvement, be sustained? And can it diffuse to other parts of U.S. industry? The critics can advance two arguments for their skepticism. First, the pattern of industrial relations we observe in Japanese industry might suggest that "company unionism" is the more "natural" counterpart to the Japanese-style production system. Second, the current industrial relations climate in the United States and the prevailing hostility to unions and to union-management cooperation put

severe pressure on cooperation at NUMMI and create barriers to the diffusion of this cooperative model.

Our hopes for the future of the NUMMI model are based on the evidence suggesting that firms or regions that can sustain the more democratic variant of the lean model are well positioned to outcompete those that cannot. While the evidence for both sides of this debate is sketchy, we believe that it supports the argument that in the absence of strong, independent unions, the Japanese-style production system risks sliding into a despotic and less productive mode:

- The institutionalization of strong worker "voice" seems to contribute significantly to NUMMI's world-class performance.²³
- By contrast, in Toyota plants in Japan, worker voice is more muted and more often subordinated to corporate interests.²⁴ This situation contributes to the maintenance of difficult working conditions reflected in poor ergonomics, excessive overtime, and stressful pressures, especially in small subcontract firms. These difficult working conditions relative to other industries make it difficult to recruit new workers, thus undermining the

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viability of the Japanese variant of the Toyota production system.²⁵

- Strong worker voice is difficult to sustain absent independent unions. In the United States, those nonunion plants that do afford workers a real voice often appear to do so as part of a union-avoidance strategy. Where these "progressive" personnel policies are due instead to the genuine humanism of the plant manager, the resulting employee relations system is fragile since workers can easily conclude that their influence is only accepted at the discretion of management and within the limits circumscribed by management.

To summarize this section, then, if we ask whether NUMMI provides as much scope as Uddevalla for the development of workers' human potential, our answer remains, unfortunately, no. But does it create an oppressive, alienating, stultifying work environment? The answer must be, emphatically, no.

If Uddevalla's productivity and quality potential were

close to NUMMI's, then its human advantages would tip the scale in Uddevalla's favor. A small gap in productivity and quality could be overcome easily by judicious public policy support. The available evidence suggests, however, that: (1) Uddevalla was not within striking difference of NUMMI's productivity and quality, and (2) NUMMI's quality of worklife, although not ideal, is in the "acceptable" range as far as workers are concerned. We conclude that Uddevalla, if it had survived, would have had to evolve in dramatically new directions in order to qualify as a viable option.

Challenging Underlying Assumptions

The goal of Uddevalla's work organization was to create a "new profession of car-builder" based on "a model drawn from the system of craftsmen and guilds, with apprentices, journeymen, and masters."²⁶ The assumption underlying this approach is that a work organization based on narrow tasks and detailed standards is intrinsically dehumanizing. We believe that the NUMMI case shows this assumption to be wrong. NUMMI's approach to standardized work shows that Tayloristic efforts to define the technically optimal "one best way" are not necessarily weapons used by management to extract maximal effort from a recalcitrant workforce. In fact, there are three ways that the knowledge required to make improvements can be used: (1) by management, coercively forcing ever-higher levels of work intensity; (2) by workers, covertly using that knowledge to reduce their own work effort (back to the "soldiering" observed by Taylor!); and (3) by the joint efforts of workers, managers, and engineers to fuel a continuous improvement of efficiency and quality without intensifying work beyond workers' capacities. We believe that the NUMMI case demonstrates that the third option is possible. Practices in Japanese plants and in other "lean" transplants probably vary considerably in this respect, but NUMMI shows that continuous improvement does not have to be based on an escalating appropriation of workers' know-how.

The contrast between Uddevalla and NUMMI also leads us to challenge a second widely held assumption: that world-class performance can be based only on very high intrinsic work satisfaction. It would be wonderful if we lived in a world where every job could be an opportunity for Maslovian self-actualization. But when products are fairly standard and mass produced, and when automation is still not cheap enough to eliminate labor-intensive methods of production, then efficiency requires narrowly specialized job assignments and for-

malized standard methods — a form of work organization that precludes the very high intrinsic work satisfaction that would, for example, stimulate workers to come in without pay on a day off to tackle a production problem. Is this equation merely the result of “corporate greed” as some critics contend? We think not: any community that needs such standardized goods will object to paying the exorbitant costs associated with an inefficient and poor-quality production organization.

As we have argued, the quality of worklife in such industries can be much improved by democratizing the work design and business governance processes. Clearly these changes leave work in the category of “instrument-

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tal necessity” rather than “self-actualization opportunity.” NUMMI shows us, however, that even when work has a basically instrumental function for workers, it can be organized to sustain both a moderately high level of worker motivation and world-class performance.²⁷

A third assumption built into the Uddevalla approach and one that underlies much of Western industry is that an increase in individual learning automatically leads to an increase in organizational learning. This is a fundamental fallacy. The Japanese model does not take organizational learning as a given; managers consciously work to create policies and practices that facilitate it.²⁸

Uddevalla designed an extremely impressive range of personal learning opportunities for its employees. Workers spent the first sixteen months developing basic skills, then progressively learned all the jobs on their teams until they could build the entire car themselves. Then they went on to develop teacher competence, team spokesperson competence, and skills in other managerial and engineering areas. But this emphasis on individual learning had no counterpart in organizational learning. Team autonomy and decision decentralization were Uddevalla's central design objectives. As a consequence, little thought was given to how work groups might learn from one another to facilitate continuous improvement. Indeed, in an interview we conducted, the plant design project leader described how the plan-

ning team ignored the need for cross-group, organizational learning: “We didn't put much thought into how to learn from other groups. Our focus was on building jobs bigger — to lengthen and widen the job; that was what we were aiming for.”

In contrast, the Japanese production model explicitly focuses on strategies for organizational learning. Standardization of work methods is a precondition for achieving this end — you cannot identify the sources of problems in a process you have not standardized. Standardization captures best practice and facilitates the diffusion of improvement ideas throughout the organization — you cannot diffuse what you have not standardized. And standardization stimulates improvement — every worker is now something of an industrial engineer. At NUMMI, the skill development strategies for individual workers are managed as a component of this process, rather than as a way of maximizing personal opportunities. As a result, training focuses on developing *deeper* knowledge, not only of the relatively narrow jobs but also of the logic of the production system, statistical process control, and problem-solving processes. Understanding a *broader* range of jobs — the focus of Uddevalla's skill development approach — is recognized as an important stimulus to *kaizen* efforts, but this broadening of skills builds on, rather than replaces, the standardized work process and the deepening of skills. Our study of NUMMI suggests that management may not be sufficiently attentive to the importance of planned skill broadening, but the sister Japanese plants systematically rotate workers through related departments over a period of years.

Conclusion

We have argued that NUMMI's combination of technical-economic and quality-of-worklife strengths makes its production system the most appropriate type for relatively repetitive, labor-intensive activities like auto assembly. It is worth asking whether this system will be undermined by the progressive automation of these activities, by changing worker expectations, and by the shift toward volatile markets, lower volumes, and greater product variety. Was Uddevalla simply ahead of its time?

At first sight, the recent innovations at Nissan's new Kyushu plant seem to support such speculation. In response to labor conditions — a tight Japanese labor market, the difficulty of attracting workers to auto assembly, and long-term projections of labor shortages — Nissan has eliminated the conveyor belt, has installed significantly more automation, and is using many of the

ergonomic job designs that characterized Uddevalla.²⁹ Toyota's new Tahara plant embodies many similar innovations. Indeed, Japanese auto executives were among the most frequent visitors to Uddevalla.

But these new plant designs do not suggest that the Japanese are switching to an Uddevalla model. First, ergonomic work task designs are a distinguishing feature

The lean production system and the Uddevalla alternative have extensive room to evolve and develop.

not of the Swedish model but of enlightened management faced with tight labor markets. Second, the work cycle has remained short and very standardized. Third, with lower volumes and greater product variety, the natural learning curve effect is even less reliable, and these plants will therefore pursue even more aggressive standardized work efforts to ensure efficiency and quality.

The more appropriate lesson to draw is that both the lean production system and the Uddevalla alternative have extensive room to evolve and develop. If Uddevalla had survived, it would have had to evolve in dramatically new ways to be competitive in productivity and quality. Whether it would have done so quickly enough and whether it would have retained its distinctive worker-oriented features is unclear.

In the case of the lean production system, we expect that it will evolve to be more employee oriented. In Japanese plants, managers will need to adjust to the long-term prospects of labor shortage and to changes in worker expectations as Japanese seek to enjoy more of the rewards of their extraordinary hard work. In Japanese production system plants outside Japan, the speed of this shift toward more employee orientation will depend on local factors. But the combination of standardized work and more democratic management has proven potent at NUMMI in its ability to sustain both continuous improvement and worker morale. It might well represent the model for the next generation of labor-intensive, mass-production activities. ♦

References

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1. By contrast, there is now a rather strong consensus on the organizational designs required to support learning in more automated settings

and where product designs or services change very frequently. On automated settings, see:

P.S. Adler, ed., *Technology and the Future of Work* (New York: Oxford University Press, 1992).

On settings where designs or services frequently change, see:

S. Davis and W. Davidson, *2020 Vision* (New York: Simon & Schuster, 1991).

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