

Rejoinder to Berggren's critique

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NUMMI vs. Uddevalla

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WHICH MODEL FOR THE LABOR-INTENSIVE PRODUCTION OF STANDARDIZED PRODUCTS — THE JAPANESE LEAN PRODUCTION MODEL REPRESENTED BY NUMMI or the holistic alternative represented by Uddevalla — is really the best organizational design to support learning? The author revisits Paul Adler and Robert Cole's article from the Spring 1993 issue of *Sloan Management Review* and presents his own side of the debate. Adler and Cole's rejoinder appears at the end of the article. ☺

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The opening sentence and central thesis of Paul Adler and Robert Cole's article are difficult to disagree with — "A consensus is emerging that the hallmark of tomorrow's most effective organizations will be their capacity to learn" [see "Designed for Learning: A Tale of Two Auto Plants," Spring 1993, reprint 3436]. In these times of uncertainty and change, processes of organizational learning are certainly of crucial interest. Adler and Cole have a much more specific mission than highlighting this point, however. They seem to suggest that there is only one way of organizing effective learning in labor-intensive production of relatively standardized goods, by using revamped and intensified Taylorism — rigid standardization, minute subdivision of labor, short-cycle tasks, and narrow job roles.¹ Is their argument that we are living in an age with no alternatives and no choices for production design and work organization?

They support their far-reaching contention by comparing two radically different auto plants — the Toyota-managed NUMMI plant in California and Volvo's small-scale Uddevalla factory. NUMMI is the successful marriage of rigorous Japanese management to a unionized American workforce. The basic production technology is the conventional assembly line; the novel features are the intense work standardization, the extensive reliance on worker input in this process, and the drive for continuous, low-cost improvement. Uddevalla's production design was completely different. Instead of one long line,

forty small parallel teams built complete cars. At regular production pace, individual cycle times ranged from 1.5 to 3.5 hours — a stark contrast to the sixty-second standards on the assembly lines. In their brief description of Uddevalla, Adler and Cole mention that there were eight assembly teams in the plant. If that figure were correct, the output of the plant would have been very low (5,000 to 6,000 cars per year). In fact, there were eight teams in every assembly shop, but the whole plant had six assembly shops and a materials shop. The precise number of teams changed as a consequence of constant efforts to improve work patterns. The longest work cycles, 3.5 hours, were for the mini-teams only.

Uddevalla's whole-car assembly was reminiscent of craft work, which some observers label "neocraft."² But the context was very different from any craft culture. Materials were collected in individual kits in a largely automated process using sophisticated new technology. And a number of technical aids were developed to make the small-scale assembly efficient and, at the same time, vastly superior ergonomically to line assembly. Furthermore, the holistic kind of assembly and its upgraded intellectual quality supported an extended collaboration among assemblers, industrial engineers, designers, and product engineers, which made for a potentially dynamic work organization, in contrast to the static character of traditional craft work.

In May 1993, the Uddevalla plant was shut down.

Because of disastrous markets and low capacity utilization, Volvo decided to consolidate all Swedish production at the main factory in Gothenburg and close the small final assembly plants in Uddevalla and Kalmar. Volvo management emphasized, however, that this was not because of competitive failures.³ Adler and Cole stress that "these plant closings should not close the debate over the significance of their innovations. . . . 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." [pp. 85-86]

Adler and Cole arrive at the same principal conclusion as Womack et al.⁴ — because of its design, Uddevalla was a low performer. "There is little doubt as to which production system is capable of delivering the greatest efficiency and quality: it is NUMMI. . . . Uddevalla was not within striking difference of NUMMI's productivity and quality." [pp. 88, 91]

To support their case, the authors present a cross-plant comparison of productivity performance. Measured in this way, NUMMI outperformed Uddevalla by requiring only twenty-one hours per car as compared with forty hours at the Swedish plant. The authors attribute this performance gap to a crucial difference in the plants' capacities for *organizational learning*. Whereas NUMMI was a very effective "learning bureaucracy," Uddevalla could not, according to Adler and Cole, translate its impressive individual learning to organizational performance. NUMMI constantly incorporated incremental improvements in its standardized and subdivided work systems, while workers at Uddevalla lacked both the motives and the mechanisms for focusing and capturing "the kinds of microscopic *kaizen* opportunities that drive NUMMI performance." [p. 89]

There are two problems with this analysis of organizational learning. The authors do not analyze the *organization* of the two plants (they focus squarely on the assembly team level), nor do they present any data on the actual *learning*. Learning is a process that must be studied over time. Rates of improvement are critical indicators of organizational learning; Adler and Cole present a comparison of performance at only one particular time.

Pitfalls of Productivity Comparisons between Plants

In this single comparison of productivity, NUMMI was superior. The problem is the next step, the authors' attempt to establish a direct link between differences in

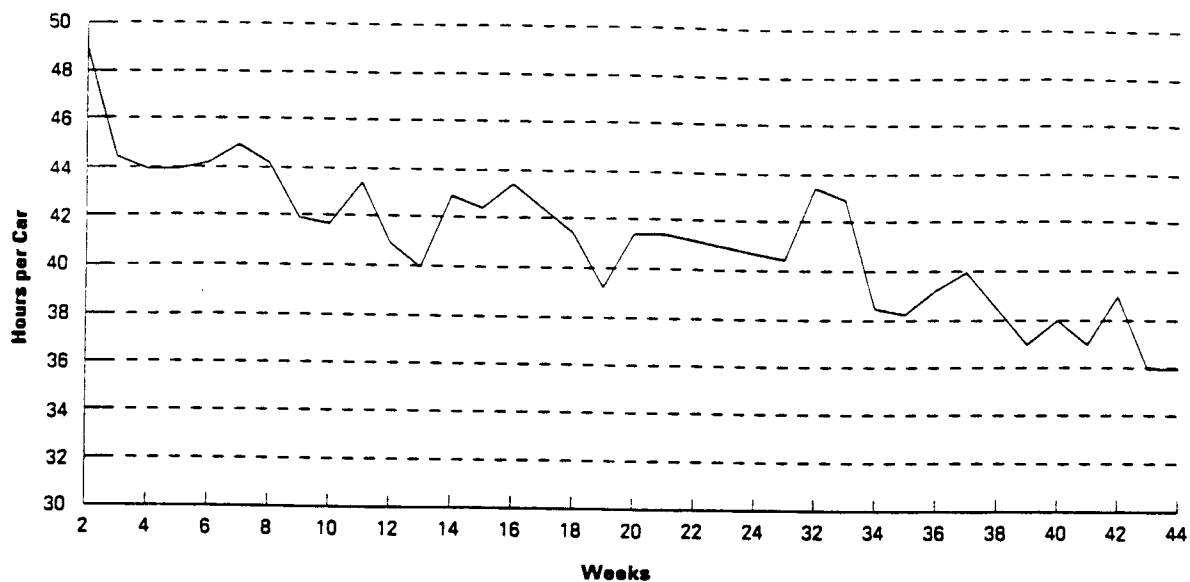
assembly hours and capabilities of organizational learning at the two plants. As emphasized by Williams et al., it is very difficult to compare productivity data between plants belonging to different companies, producing different products, using different component suppliers, etc.⁵ The problem is not to establish the number of assembly hours required; the intricate task is to interpret the differences. In the case of NUMMI and Uddevalla, the performance gap is influenced by a number of factors outside the control of the final assembly process:

- First, there are important differences in product characteristics and product manufacturability. NUMMI workers would certainly appear to be much less productive if they had to assemble Volvo cars.
- Second, the quality of the supplied components is not the same. This is true not only for parts from external suppliers but also for components made in the company. For example, according to a 1990 Swedish study of design problems, the precision of Volvo's and Toyota's body components differed by an order of magnitude.⁶ This, of course, affected productivity in final assembly in a substantial way.
- Third, as Williams et al. have demonstrated, capacity utilization must be included in any serious comparison of plant productivity.⁷ Womack et al. and Adler and Cole consistently overlook this factor. Since Uddevalla utilized only 50 percent of its one-shift capacity in 1991 and 1992, while NUMMI operated much closer to optimal efficiency, Volvo's plant is again at a disadvantage.
- Fourth, the two plants are differently positioned on their respective learning curves. NUMMI adopted a mature, fine-tuned concept, developed for decades in Japan; Uddevalla had just established its learning curve for a qualitatively novel concept and needed much more experience to fine-tune and synchronize its assembly design, materials control, worker training, management organization, information systems, and so forth. In a discussion of organizational learning, this is a particularly relevant point.

Learning and Progress at Uddevalla

To assess the Uddevalla model's contribution, it is essential to focus on its rate of improvement, rather than on the absolute productivity during its brief existence.⁸ According to Adler and Cole's theory, productivity development at the plant should have been flat, since there were no mechanisms for leveraging individual worker achievements. From fall 1990, when all production and materials handling equipment was in place, to November 1992, when the closure decision was announced, assem-

Figure 1 Productivity Progress at Uddevalla (January 1992 – November 1992)



Note: Between weeks 24 and 32, productivity was not measured because of worker absences during summer vacations.

bly time per car on average was reduced by one hour every month. During 1992, productivity improvement accelerated. Figure 1 illustrates the actual productivity progress at the plant from January to November 1992. A look at this graph makes it difficult to maintain that Uddevalla did not have a significant capacity for systematic, organizational learning.

In terms of quality, Uddevalla reached the level of the Gothenburg plant after one year of operation, falling far short of expectations. Management had believed that the plant's combination of highly motivated and skilled workers and short feedback loops would "automatically" result in *excellent* quality. In order to build world-class automobiles, however, consistency and systematic procedures are also critical, so Uddevalla started to train workers in new, rigorous ways of team-based quality assurance and to develop selected teams into models. The result was a 27 percent decrease in defects per car during 1992 — and that was only the beginning. Uddevalla surpassed Gothenburg's quality performance at a time when all of Volvo improved its quality record considerably, as reflected in the J.D. Power scores published in May 1993. While the entire auto industry improved its scores, compared with the 1992 figures, Volvo advanced from rank 15 to rank 11 of the 34 participating automakers. The 940 model — assembled at Uddevalla, Gothenburg, and Kalmar — was ranked the best European car and improved its record from 132 to 87 problems per 100 cars.⁹

If Uddevalla was only a place for individual learning, as Adler and Cole contend, one would expect a very un-

even mixture of high-performing and low-performing teams, and no mechanisms for lifting the laggards. This view is difficult to reconcile with the actual development at the plant. Progress in quality and productivity was particularly rapid in the fall of 1992, and this acceleration coincided with other advances. Most important, the planning process was completely revamped. Beginning on October 1, 1992, the plant started to assemble all cars for the Swedish market on customer orders only. Volvo encouraged dealers to contact the plant directly, and customers not satisfied with delivery dates could call Uddevalla themselves. One month later, it extended this principle of custom assembly to the whole European market. Uddevalla planners told European dealers that the plant would not promise any specific delivery times for cars that had been scheduled by the central planning system on the basis of market forecasts. Instead they would guarantee delivery of any custom-ordered car within four weeks. The response from European importers was overwhelming. Total lead times, from customer order to delivery, were reduced from sixty to thirty days.

Uddevalla planned to customize production further by including traditional dealer installations, such as the mounting of tow hooks, in the factory process. Preliminary studies demonstrated significant gains in assembly time and quality, as well as in handling costs and lead times to the car buyer. Adler and Cole do not discuss the critical link between the plant and its customers, and how different production concepts affect this rela-

relationship. Uddevalla's flexible teams had no problem handling additional variations, but, at conventional assembly plants, such customization aggravates the problem of line balancing. Unfortunately, Adler and Cole confuse balancing losses with setup times. Setup times refer to time needed to change between different products. Balancing losses occur because the work tasks in a serial flow do not require the same amount of time.¹⁰

The orthodox Toyota system NUMMI illustrates is certainly less rigid than traditional mass production, but there are obvious limits to its flexibility. This is apparent in the current Japanese debate, and one of the reasons for Toyota's experimentation with different assembly designs and work patterns at the new Tahara and Kyushu plants.¹¹

A Missing Link: Plant Management's Importance

Uddevalla's accelerated progress in the fall of 1992 cannot be explained within Adler and Cole's framework. They emphasize the importance of organizational learning but treat the organization of the two plants simplistically. Thus, under the heading "Comparing Organizational Designs," there is a description of only the assembly teams at Uddevalla. There is no discussion of NUMMI management's role and competencies.¹² By focusing squarely on the shop-floor level, Adler and Cole miss an important and paradoxical aspect of the Uddevalla story. In the assembly shops, the organization was "flat," but for a long time, the advanced assembly teams coexisted with a traditional management hierarchy, underscored by the detached and secluded building where the managers had their offices.

During the early years, the plant developed despite this anomaly, but, in early 1992, there were clear signs of stagnation. The plant could not advance only on the strength of its team systems; it needed a congenial plant organization and managerial structure. In mid-1992, after a difficult period of soul searching, management put in place a different and very process-oriented organization, headed by a new plant manager who had been extremely successful in reorganizing the pilot plants in Volvo's development and product engineering departments. In Uddevalla's new structure, there were only two hierarchical levels, shop-floor and plant management. As before, the assembly and materials shops had on average seventy workers organized in teams with rotating, hourly team leaders. They communicated directly with the shop managers, who in turn made up the bulk of the plant's new management committee. This participation of first-line managers in Uddevalla's central governing body re-

flected the very strong emphasis on process and process development (including cross-team learning) in the new organizational design. For the new plant manager, the compressed hierarchy was only the first step. Next, he planned to move all managers and administrative officers from the office building to facilities directly adjacent to the production process. In an interview, he mused, "Some of the functional heads did not believe me, but I intended to move [my office] first, and then the others would have no choice but to follow suit."

Salaried employees were involved in direct production activities in order to learn about the plant's manufacturing problems. To gain first-hand experience, the new managers of the assembly shops started to learn how to assemble not complete cars (in most cases, too daunting a task), but fairly complex subassemblies. The remaining industrial engineers, who had been relocated from the office to the assembly and materials shops, spent half their time building cars in the assembly teams. These initiatives were not just cultural exercises but served well-defined purposes, one of the most important being to articulate and diffuse best-practice methods plantwide. Aggressive performance demands provided the impetus, and the presence and participation of the support staff (engineers and others) made it possible to elaborate on and spread such procedures swiftly. As part of this drive, there was the successful introduction of a plantwide *kaizen* program in fall 1992. The advanced team structure turned out to be ideally suited for sustaining continuous improvement activities. In March 1993, team members commented, "Previously, we had only felt pressure from management to reach our targets. Now we really got support and did a lot of things, often small improvements we had never bothered to do before."

Adler and Cole quite correctly emphasize that, in both concepts, NUMMI and Uddevalla, learning and evolution do occur: "A fair assessment should assume that both approaches are capable of learning and evolution." [p. 88] Nonetheless, they tend to interpret their impressions from the 1991 visit to Uddevalla in a static way, as inherent features of the concept. "At Uddevalla," they write, "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 a result, the Uddevalla workers quickly discarded them and, along with them, the very idea of detailed methods and standards. . . . This management philosophy sounds more like abandonment than empowerment." [p. 90] Was this interregnum an inevitable con-

sequence of the production design, as Adler and Cole contend? Managers and union leaders alike offer a very different explanation. During the planning phase at Uddevalla, there were few traditional engineers; in fact, the rigid approach of the production engineering department was a major obstacle once the design team decided to abandon traditional solutions. Thus, when the plant came on stream, there were practically no engineers at Volvo's traditional plants who had a good grasp of the car assembly. For Uddevalla, it was very hard to find manufacturing and industrial engineers with skills that matched its new teams' holistic competencies. Those engineers recruited in the early years were uneasy about this situation and were only too happy to avoid close cooperation with the assembly teams by retreating to their offices. Management had to promote the most competent assemblers to technical positions in order to develop new forms of engineering support, a long-term process. By the time Adler visited the plant in mid-1991, these endeavors had begun to pay off: the first new procedure documents had been completed and they were introduced in the assembly teams, but there was still a long way to go.

Adler and Cole argue that an "assumption built into the Uddevalla approach . . . is that an increase in individual learning automatically leads to an increase in organizational learning. This is a fundamental fallacy." [p. 92] True, some managers did not reflect on interteam learning during the design phase. Nevertheless, the problem of finding effective ways to diffuse methods and practices from high-performance teams to lesser performing units, that is, organizational learning, had been a management preoccupation since at least 1990. In September 1990, I discussed this problem with a number of managers at different levels, including the general manager. The challenge was to organize in ways congenial to the new mode of production. In 1991 and early 1992, the managerial answer was to strengthen the hierarchy and expand the technical experts' role. The new process-driven organization represented a very different solution, combining radical decentralization, participative management, and strong performance orientation. The *kaizen* program was one approach to developing and diffusing best practices. To further increase knowledge transfer, the plant manager envisioned a comprehensive system of personnel rotation, within and between assembly shops, and eventually between the assembly department and materials handling. According to managers I interviewed during my evaluation study, it was only three years after its inauguration that Uddevalla acquired an overall organizational form that fit the team structure and production

design. As the plant's former personnel head, a shop manager in the new organization, pointed out:

We had to learn so many things from scratch, starting with a process of unlearning, getting rid of previous conceptions and behavior. Only in September 1992 did we find an organization suited to our production concept. We also introduced a new program for leadership development, which was essential for all shop managers and the new management board. The first session of the program took place in November, on the same day the close-down decision was announced.

Holistic versus Fragmented Learning

Adler and Cole suggest that organizational learning in labor-intensive volume production by necessity requires minutely subdivided, standardized, and regimented work. NUMMI seems to demonstrate that organizational learning is possible under such a factory regime — given certain organizational properties that Adler and Cole do not discuss, such as a hard-working and hard-driving management.¹³ They do not prove, however, that this is the only way. Nor do they discuss possible costs of rigid standardization, costs not only in terms of excessive monotony and work strictures, but also in efficiency. An implicit assumption in the Toyota type of standardization of every movement is that workers are uniform in size, strength, and so on. When this kind of standardization is enforced, the result is not only poor ergonomics but also uncomfortable and subefficient ways of working for all "nonstandard" employees. Uddevalla applied a very different logic of learning, which relied on two fundamental principles:¹⁴

- The *holistic* principle, i.e., the importance of understanding the whole (in this case, the assembly of the whole car) and the interdependencies of all constituent parts. Accordingly, the learning process encompassed the work in its entirety.
- The *reflective* principle, i.e., skill formation as an integration of mental maps and manual skills. For assembly workers at the Uddevalla plant, performing long and complex tasks was not enough; equally important was achieving an articulated and detailed intellectual understanding of the process. Job design and training were thus very different from conventional job enlargement, which is usually a mere quantitative inclusion of additional repetitive tasks. It could be argued that the focus on the whole, of the process in its entirety, has a price, that there is a tradeoff in terms of a relative lack of attention to detail. On the other hand, Uddevalla's learning

logic was the basis for new and powerful organizational capabilities. Because it was not based on fragmented tasks and rote learning, its job design and production methods resulted in a generalized assembly competency of great potential value.

One indication of this competency was the low effort needed to introduce annual model changes at the plant. The three model changes in 1990, 1991, and 1992 were introduced with between 25 percent and 50 percent lower costs per car compared with the Gothenburg plant. Uddevalla's investment in tools was approximately the same as Gothenburg's, but the amount spent on training was only 40 percent of the training costs at the main plant (both costs are measured in dollars per car). According to conventional wisdom, the long work cycles at Uddevalla should have required a much longer time to learn than the standardized short cycles on conventional assembly lines. In fact, Uddevalla returned to normal productivity in half the time after a model change, compared with Gothenburg. In 1992, the best Uddevalla teams needed to build only two to three cars (approximately one day) before resuming 95 percent of normal

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production pace. The least efficient teams needed five to six cars, or two days. One reason for the smooth model changes was that assembly teams at Uddevalla implemented the changes, studied the new instructions, and rearranged their workplaces. Second, the system of materials provision — the kits — helped assemblers learn the new annual model. Third, the new skills, generated by the holistic assembly process, made it easy for car builders to analyze the new product, identify critical changes and sticky points, and concentrate on them.

Another indication of the power of the holistic assembly principles was the emerging dialogue and interaction between assembly teams and product engineers during pilot runs of new annual models. According to Gothenburg product engineers, who had experienced all Volvo's assembly plants, discussions with skilled workers

at Uddevalla, especially the whole-car assemblers, were often very productive. These problem-solving dialogues were not constrained by the rigid sequencing of the assembly line system; the workers could question proposed assembly methods and develop innovative solutions. As one product engineer observed:

In 1992, when the last model change took place, the assembly workers' skill level was very high. We had a very good response at the pilot run; they were more competent and more curious than at any of the other plants. What the plant lacked, as a consequence of its short time of operation, was a more advanced professional knowledge. In this respect, Kalmar was the best of all Volvo plants. If Uddevalla had been allowed to continue and develop its competence, it would have been outstanding and our dialogue with the workers truly professional.

Adler and Cole rightly stress the paramount importance of learning. However, they have not established that close regimentation of fragmented tasks is the only viable basis for organizational learning. In their comparison of Uddevalla and NUMMI, they have neither documented processes of learning (which requires studies of improvement over time rather than cross-sectional performance comparisons) nor analyzed the significance of different organizational and managerial structures at the plant level for these processes. In their account, they give the impression that productivity improvement in the Toyota system is entirely based on worker suggestions for small, but never-ending, improvements.

This is not the case at Toyota Motor Corporation in Japan, however. Workers are organized in small-group activities like quality control circles, but the company does not expect much productivity improvement from these circles; their main importance is to boost morale and commitment. The real source of incremental productivity increases is the separate *kaizen* groups of supervisors and foremen, supported by production engineers and skilled maintenance workers, if needed. The same division of labor exists within other Japanese mass production industries, where there are small-group activities, but, in Taylorized and rigidly standardized operations, the skills of production workers are too limited and circumscribed to allow any significant contribution to process improvement. Foremen, supervisors, and engineers play the key role.

At Mitsubishi's main Japanese plant in Mizushima, for example, management estimates that design changes for easy manufacture accounted for 50 percent of the

plant's very impressive productivity improvement during the 1980s, automation contributed to another 30 percent, and *kaizen* at the workplace accounted for the final 20 percent.¹⁵ Workers at Mizushima are organized in small groups with the usual high output of suggestions. The major role in workplace productivity progress, however, is played by specialized *kaizen* teams, comprising highly experienced and selected operators and maintenance workers. It is very different at factories where all workers are highly skilled, as in the machine tool industry. Here, the contribution of production workers to productivity improvement is of an altogether different magnitude, and specialized *kaizen* teams seldom exist.¹⁶ Now, the only problem for Adler and Cole's argument is that the nature of work in these industries is more similar to the Uddevalla operation than to NUMMI.

Many researchers are so impressed by the sheer amount of small-group activities and the number of worker suggestions that they fail to gather any facts about their real contribution to productivity development or investigate the role of specialists and other employees in process development. Unfortunately, Adler and Cole do not provide any facts in this crucial area. The idea of "democratic Taylorism" seems to be in serious need of substantiation.

A New Round of the Circle . . .

Academic debate and corporate practice in the field of industrial management tend to move in circles that are closely linked to business cycles. Forty years ago, American sociologists interested in workers' experiences interviewed an auto worker who described his job:

The assembly line is no place to work, I can tell you. There is nothing more discouraging than having a barrel beside you with 10,000 bolts in it and using them all up. Then you get a barrel with another 10,000 bolts and you know every one of those 10,000 has to be picked up and put in exactly the same place as the last 10,000 bolts.¹⁷

In the late sixties and early seventies, the entire Western industrial world experienced a revolt against Taylorism and degraded work in mass production. This fostered widespread interest in organizational reforms and sociotechnical engineering. However, in contrast to the United States, where this interest quickly receded during the recession in the late seventies, in Sweden, the focus on job redesign and "humanistic manufacturing" became an enduring feature, gaining new momentum

in the late eighties. One reason was the tight labor market. The high union participation, with more than 80 percent of all employees belonging to unions (compared to 15 percent in the United States), also contributed to the broad interest in work reform. A similar interest in new production concepts and "anthropocentric" job design developed in other European countries, such as Germany.

At the same time, Japanese-style production was increasingly being applied in the Western world, e.g.,

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NUMMI. The success of these transplants was due to the Japanese firms' ability to carefully select their workforces. This required an abundance of applicants, possible in the United States because of the large wage differentials between auto jobs and unskilled factory and service jobs, and in the United Kingdom because of high unemployment. But the Japanese firms also had to adapt the transplants to make them more attractive, such as establishing a more egalitarian profile and applying a basically flat wage structure, not the elaborate Japanese personnel evaluation system (*satei*).

Japanese practices constitute a deeply ambiguous package, however. Some parts are irrefutable contributions, such as the dramatic reduction of setup times, the integrated quality control approach, or the emphasis on job security and "working with pride." But other parts of the package result in regressive working conditions because of the intense machine-pacing of human tasks; the rigid demands to fulfill production quotas in the tightly coupled system; the close individual surveillance and excessively regimented workplace; and more generally, the failure to adapt ergonomic conditions and the working pace to long-term human requirements.

There is a paradox in the current debate. Adler and Cole present the Toyota production system as compatible with the aspirations of a majority of workers. In Japan, however, the shortcomings listed above are intensely debated. Japanese companies have actually had a much harder time recruiting workers in Japan than in the United States or Britain. The recruitment problem is not a transient phenomenon that will disappear as a result of the current crises. According to labor market

economist Haruo Shimada, Japan is experiencing a profound demographic change, and there is long-term shrinkage at the younger end of the labor force. Further, there is a structural change in Japanese values. Affluent and highly educated youngsters shun dirty and repetitive jobs. As Shimada emphasizes: "Postwar Japan's rapid economic growth was sustained by the availability of large numbers of young workers who wanted to work and were willing to work for rather low wages."¹⁸ In the 1990s, these conditions no longer exist.

... or a New Synthesis?

The dynamics of Japanese car production have been fueled by the fierce domestic competition in Japan's home market. By contrast, Swedish manufacturing firms in the 1980s encountered a very demanding labor market, probably the most exacting in the world. Four important Swedish contributions to the renewal of work organization and job design were:

1. Integration of fragmented mass production work to holistic tasks. The Swedish automakers' "assembly trajectory" demonstrates that alternatives to repetitive and confined work structures are possible. They are technically feasible, compatible with very varied market demands, and socially desirable, because they result in qualitative job enrichment and a reduction in physical workloads.
2. Comprehensive improvement in the ergonomics of manual work. At Uddevalla, this effort was explicitly related to the high proportion of female workers (40 percent) and the need to adapt tools and methods to human differences, recognizing that all workers are not the same size and strength.
3. Efforts to make work systems less rigidly coupled and more adaptable to diverse human needs. This too was a response to an advanced labor market with high labor-force participation, a large number of female workers, and virtually no unemployment. Auto firms were not able to target a carefully selected, male workforce and had to accommodate employees who have important obligations outside work. Consequently, a demand for total commitment in the Japanese style was neither possible nor desirable. Forms of production control that rely permanently on overtime for smooth functioning were infeasible for all large firms.
4. Dealing with a high degree of union involvement — in decision-making and planning processes — as independent partners with their own legitimate interests. The participation may cause controversy and complications, but it also creates a way to articulate complex social demands that the Japanese structure of enterprise

union cannot match. (An advanced case in the United States is Saturn.) When JAW, the Japanese equivalent of UAW, recently adopted a more assertive and reformative stance, it had no means to get the enterprise unions to effectively pursue this policy, because they are locked into the system of company competition.

In the 1990s, the central issue for workplace design is not how to emulate the standard Toyota model, but how to create a new synthesis of Japanese contributions to production management and product design, innovative American integrated corporate strategies (such as "time-based competition"), and West European (Swedish, German, and so forth) job design for empowerment and reskilling. A tricky component in such a synthetic endeavor is the role of standards in organizational improvement. Available evidence does not support the argument that a recourse to Taylorism is the only way to promote learning in labor-intensive production. When, for example, Uddevalla's autonomous teams and holistic job design were supported by a participative and hard-driving management, the result was accelerated and simultaneous advances in productivity, quality, and market responsiveness. The plant was close to a real breakthrough when top management decided to lay it idle for capacity reasons.

Holistic manufacturing systems certainly benefit from close attention to details, order, and discipline (concerning tools and quality control procedures, for example) and from more systematic efforts to develop reliable standards for critical operations. Such efforts would help lagging teams, facilitate the instruction of new employees, and make it possible for qualified teams to concentrate on solving more complex problems and developing their methods. In sailing, good crews maintain meticulous standards and discipline for sails, halyards, ropes, tools, nautical instruments, and safety equipment in order to concentrate on the creative parts of the adventure, respond to unpredictable shifts, and meet emergencies promptly. The same applies in manufacturing. The Toyota type of regimentation, however, is incompatible with the holistic work concept. Such fragmentation destroys innovative and flexible capability and the potential for forming teams for integrated design, manufacture, and marketing.

There is a need for a new synthesis, but its conditions and determinants are socially contingent. High unemployment, large inequalities in income, deficient social protection, and low labor standards facilitate adopting the regressive features of lean production. Advanced industrial and labor market policies and comprehensive social security could cause competitive problems in the short term. But, in the long term, with firms,

financiers, and management committed to the industry, such selective disadvantages will stimulate innovation, upgrading, and sustainable solutions. Sophisticated social demands are the basis for the development of competitive humanistic manufacturing. Here labor and government also have an important role to play, in Europe and in the United States. ♦

References

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5. K. Williams, C. Haslam, J. Williams, and T. Cutler, "Against Lean Production," *Economy and Society* 21 (1992): 321-354.
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7. Williams et al. (1992).
8. I gathered the facts and figures presented in this article as part of a comprehensive evaluation of Volvo's small-scale plants, conducted from December 1992 to May 1993. See: C. Berggren, "Excellence or Nightmare? An Evaluation of Volvo's Small-Scale Plants" (Stockholm, Sweden: Royal Institute of Technology, mimeo, 1993).
9. The monthly J.D. Power figures are not statistically significant because of the low number of cars surveyed. The trend is consistent with internal Volvo audits, however.
10. At all stations except the top (in which 100 percent of the time is used), there are micropauses of unused time. Balancing losses tend to increase with shorter work cycles because it becomes ever harder to achieve an even division of tasks. One specific type of balancing loss, variant losses, increases with growing product variation. See: R. Wild, "On the Selection of Mass Production Systems," *International Journal of Production Research* 5 (1975); and C. Berggren, *Alternatives to Lean Production: Work Organization in the Swedish Auto Industry* (Ithaca, New York: ILR Press, 1992).
11. M. Nomura, "Farewell to 'Toyotism'? Recent Trend of a Japanese Automobile Company" (Okayama, Japan: Okayama University, Department of Economics, mimeo, 1992).
12. A comparison with two much less successful unionized Japanese transplants, Mazda/AutoAlliance in Flat Rock, Michigan, and GM/Suzuki in Ingersoll, Ontario, is enough to highlight this point. Both plants subscribe to the same concepts of production control and work design as NUMMI, but the outcome is very different. When I visited AutoAlliance in May 1993, a human resource manager told me that they had "a very unhappy workforce," and that he expected and hoped that Ford would take charge and get the plant on track again. See: L. Babson, "Lean or Mean: The MIT Model and Lean Production at Mazda," *Labor Studies Journal* 18 (1993): 3-24.
13. According to M. Nomura, "Ohno [Toyota vice president] named this [Toyota's] improvement system an 'embarrassing system,' which means the system continuously embarrasses production managers and supervisors." See: Nomura (1992), p. 17.
14. The principles are discussed in detail in: K. Ellegård, T. Engström, and L. Nilsson, *Reforming Industrial Work — Principles and Realities in the Planning of Volvo's Car Assembly Plant in Uddevalla* (Stockholm, Sweden: The Swedish Work Environment Fund, 1993).
15. Interview with deputy head of the production engineering department, Mitsubishi plant, Mizushima, Japan, 18 October 1993.
16. See M. Nomura, "Skills and Division of Labor: Japanese Companies and Taylorism" (Tokyo, Japan: Ochanomizu Shobo, 1993); and M. Nomura, "Toyotism: Maturity and Metamorphosis of a Japanese Automobile Company" (Kyoto, Japan: Minerva Shobo, 1993).
17. C. Walker and R. Guest, *The Man on the Assembly Line* (Cambridge, Massachusetts: Harvard University Press, 1952).
18. H. Shimada, "Japan's Changing Labor Market," *Journal of Japanese Trade & Industry* 4 (1991): 8-11.

Rejoinder

Paul S. Adler • Robert E. Cole

Christian Berggren's response to our article is gratifying because, like him, we believe that the debate over the merits of different production systems is important. There is more at stake than the competitive success of auto companies. The outcome of this debate will also shape the future quality of work for millions of people around the world. We therefore want to use this opportunity to clarify the points of agreement and disagreement and, more importantly perhaps, to identify the is-

ssues that will need to be resolved in future rounds of research and dialogue.

Berggren makes a number of points concerning the form of such debates that we find very compelling:

- All performance comparisons are methodologically difficult.
- In particular, performance should be studied over time to fully understand its determinants and potential.
- Uddevalla's productivity and quality performance suf-

ferred from manufacturability problems that originated in the design of the Volvo.

- Performance nevertheless improved dramatically over the plant's short life.
- The strengths and weaknesses of the plant's performance cannot be explained by the peculiarities of its shop-floor organization alone, since the broader management system and values also play a role.

We also find compelling some of Berggren's claims for the enduring legacy of Uddevalla:

- Whether or not Uddevalla was capable of world-class performance in ongoing production tasks, it was probably very well designed for fast, cost-effective model changes and high-variety production.
- Uddevalla was very innovative in improving the ergonomics of assembly work.
- Uddevalla developed innovative approaches to the training problem for long-cycle jobs.
- Uddevalla provided a superior quality-of-work environment.

The heart of the debate, however, is whether Uddevalla's or NUMMI's form of work organization better supports the kind of sustained rapid organizational learning necessary for world-class competitive performance in auto assembly. Here Berggren is less convincing.

A first difficulty with Berggren's argument is that he spends too much time critiquing a straw man. He focuses much of his criticism against the "rigid standardization" of the "intensified Taylorism" he identifies with NUMMI. He quotes from a 1950 interview that Walker and Guest conducted with a worker describing the alienated quality of his work — "a barrel with another 10,000 bolts" — to characterize what he asserts is the regression of the NUMMI model to an impoverished quality of work in a "new round of the circle." We used the term "democratic Taylorism" precisely to convey the idea that NUMMI stands traditional Taylorism on its head. Instead of a set of prescribed methods and standards being imposed on workers to extract greater work intensity, the NUMMI model motivates worker input to drive an immensely powerful process of continuous improvement. The commitment to standardized methods was an important enabler for that improvement process. In this case, it is Berggren who imposes a static model on a dynamic process.

Berggren's argument also raises three, more substantive issues that we feel will merit closer attention from all of us in future rounds of research and dialogue:

First, could Uddevalla have reached world-class productivity and quality? As methodologically difficult as

Table 1 Uddevalla's Productivity Compared with Other Assembly Plants' Productivity*

Year	Assembly Plant	Hours per Car
1992	Uddevalla Actual	25.9
1993	Uddevalla Projected	17.1
1989	Japanese Luxury (average)	9.1
1989	Japanese Volume (average)	9.1
1989	European Luxury (average)	30.8
1989	European Luxury (best)	20.1
1989	European Volume (average)	19.2
1989	U.S. Luxury (average)	19.3
1989	U.S. Luxury (best)	18
1989	U.S. Volume (average)	13.5

* Adjusted direct plus indirect assembly hours, calculated as explained in footnote 1.

comparisons of performance are, any argument about the relative merits of different production systems cannot avoid them. These merits cannot be evaluated by ignoring the brutal assessment imposed by the competitive process. Berggren makes a reasonable argument that a direct comparison of NUMMI and Uddevalla hours per vehicle is likely to be misleading. However, with the generous help of John Paul MacDuffie, we have been able to use the International Motor Vehicle Program (IMVP) data to make some comparisons — albeit only approximate — with various types of car producers.

In September 1992, Uddevalla was taking an average of thirty-six hours to assemble a car. The announced target for 1993 was twenty-five hours — although Berggren's Figure 1 makes this target seem unrealistic, since it would imply an acceleration of an already rapid rate of improvement, in a phase of Uddevalla's development in which one would expect a deceleration. How do these actual and projected figures compare with other assembly plants? Several adjustments are necessary to account for differences in the scope of plant responsibilities, product characteristics, salaried head count, and absenteeism.¹ The net results are presented in Table 1.

Uddevalla's 1992 performance was better than the average for the European luxury producers, but worse than the best of them as well as worse than the average for U.S. and Japanese luxury producers. Note too that the IMVP data are for 1989, and the performance of the Japanese and European competitors has certainly improved since then, with gains in Europe and the United States ranging from 15 percent to 25 percent over the period. While the comparison with the Japanese

luxury segment may be a little unfair, since in 1989 it did not include cars as sophisticated as the Volvo 940, comparison with the European luxury segment is probably overgenerous. The European luxury segment after all included Daimler-Benz and Jaguar, while Uddevalla's product complexity brought it closer to the volume rather than the luxury segment. Uddevalla's projected 1993 figure looks much better, but still far from the performance of their Japanese luxury or volume segment competitors.

A similar disturbing gap appears in the quality results. Berggren tells us that the combined J.D. Power product rating for Uddevalla, Gothenberg, and Kalmar on the Volvo 940 was 87 in 1993. These results can be compared to the 1993 score of 54 for the Lexus LS400 (the top-ranked car) and 77 for the Toyota Corolla (the top-ranked small car). Volvo's 1993 results would not even rank in the top ten of the U.S. market.

Berggren minimizes the weight of such productivity and quality comparisons by pointing out that they are affected by the manufacturability of the vehicle design. And Volvo's vehicles rank very low in manufacturability. But a compelling defense of the Uddevalla model would need to show that, with a highly manufacturable design, the plant could have performed at world-class levels. Much more careful data analysis will be needed to settle this question, but, in the interim, it is hardly surprising that the Uddevalla proponents encounter great skepticism.

Berggren attempts to minimize further the weight of such comparisons of productivity and quality by focusing on the dramatic improvements in productivity and quality achieved at Uddevalla, especially in the year preceding its closure. These improvements are undeniable. The issue, however, is whether they were a temporary development or a prelude to sustained high rates of growth in productivity and quality. Berggren assumes the latter but provides no supporting data other than the quotes from managers on their plans for the future.

We are not so sure that Uddevalla's rapid rate of improvement would have been sustained. Any new plant, even under traditional management, undergoes rapid productivity improvement in its initial stages as workers and managers scramble to learn their jobs and establish their routines. The rate of change typically then slows considerably as people begin to cling to their "normal" routines. Many of the organizational learning activities in the design and startup phase of Uddevalla were run as independent projects staffed by personnel and external consultants engaged on a temporary basis. However, as Ellegård and her associates acknowledge — based on

their rather intimate knowledge of Uddevalla's development — such hard-won knowledge is easily lost to the organization when it is based on such temporary project teams.² We therefore need to examine whether the mechanisms had been put in place to ensure continued high rates of growth in productivity and quality.

This leads to the second issue: whether Uddevalla's progress signifies a high capacity for organizational learning, distinct from individual learning. There was clearly an enormous amount of individual learning driven by Uddevalla's "holistic" and "reflective" work organization principles, based on the extended work cycle and facilitated by some very innovative training approaches. This individual learning no doubt accounted for a lot of Uddevalla's performance improvement.

At the same time, there was also a great deal of organizational learning. In our original article, we stressed the *relative* emphasis in Uddevalla on individual as distinct from organizational learning (not the absence of organizational learning as Berggren claims). We should have further distinguished startup learning during production ramp-up from ongoing learning during normal operations. Berggren provides strong evidence for the former but very little for the latter. We still have little reason to

We still have little reason to believe that the key mechanisms for sustained organizational learning were being installed at Uddevalla.

believe that the key mechanisms for sustained organizational learning were being installed at Uddevalla. It would have been very useful to know the real long-term effects of the industrial engineers working part-time in production teams, the new procedure documents, and the *kaizen* program. Fate made that impossible. But it is noteworthy that, whereas Toyota has spent decades progressively strengthening its *kaizen* capabilities, Berggren writes as if a comparable organizational learning capability could have been developed at Uddevalla in a matter of months. Berggren seems to underestimate grossly the challenge of learning to learn, leaving us even more doubtful that he appreciates the nature of organizational learning.

Berggren suggests that an interesting test of the capacity for organizational learning is whether all the

teams were performing at comparable levels. Unfortunately, he does not offer any data to buttress his affirmative answer. During our visit, several senior managers made the opposite evaluation: they were very concerned at the great unevenness across teams. Rotating industrial engineers and workers among teams seems like one potentially useful way to ameliorate the problem. But these

What are the key dimensions of performance along which we should judge competing models of production?

rotations can neither identify nor disseminate many of the competitively significant improvements if the teams' work processes have not been formalized and standardized and measured in great detail. Berggren seems close to conceding this point when he writes that "It could be argued that the focus on the whole, on the process in its entirety, has a price, that there is a tradeoff in terms of a relative lack of attention to detail." Berggren's analogy with sailing is revealing: world-class sailors show a dedication to the mastery of incredibly fine-grained methods and tight standards — an approach that seems entirely foreign to the Uddevalla spirit.

This leads us to the third issue: What are the key dimensions of performance along which we should judge competing models of production? In many ways, this seems to be at the heart of Berggren's disagreement with us. If Berggren sees the sacrifice of attention to detail as worthwhile, it is in large part because he believes that the productivity and quality performance of ongoing operations need to be weighed against (1) the intrinsic quality of work, (2) the flexibility of operations, and (3) the capacity for effective dialogue with product design staff. Each of these propositions suggests some key issues for future research.

Our original article dealt at some length with the quality-of-work issue. Berggren does not contest our assertion that NUMMI's quality of work was sufficiently high to sustain workers' commitment. However, he argues that this outcome depends as much on the quality of the broader management system as on the nature of the work organization. We agree wholeheartedly and, indeed, would strengthen his point: the highly disciplined Toyota approach is viable from a human point of

view only when associated with a management system considerably more "enlightened" than that found in the average U.S. plant. The fact that many young Japanese are shunning manufacturing jobs does not seem to us evidence that the Toyota production system is obsolete, rather that Japan has experienced a labor shortage (at least until the "bubble" burst in 1989).

Uddevalla's holistic approach did indeed seem to add to its ability to rapidly ramp up production of new models. Uddevalla invested much more in worker training than the conventional plant does, and the work teams operated in parallel. As a result, there were some forty highly qualified teams working simultaneously on redesigning the whole work sequence. With this organizational design, the plant could return to its performance levels very rapidly. This capability would be worth the required sacrifice of performance in ongoing operations if Uddevalla were a prototype shop or a "development factory," such as Toshiba uses to debug new designs before the product is sent to regular factories for mass production. But the practice of frequent product introductions in the auto industry still leaves the industry and Uddevalla much closer to the mass production end of the spectrum. Given the high ratio of routine to nonroutine tasks that we find in auto assembly, we find it hard to believe that the sacrifice of efficiency and performance is worth the gains in flexibility. Further research should test this argument. We should note too that even if Uddevalla was much faster and cheaper than Gothenburg in model changeover, its performance compared to Toyota remains in doubt, given Toyota's renown for rapid model introduction.

Finally, Berggren also sees great benefit in the way the holistic approach augments the plant personnel's ability to communicate with product engineers. While the breadth of Uddevalla's workers' skills was clearly of value to Volvo, the incredible depth of knowledge that comes from Toyota's obsession with production details probably creates even greater competence in manufacturability assurance. Toyota derives considerable benefit from involving shop-floor personnel in the design improvement process through the use of special project teams.

Where does this leave us with respect to Berggren's argument for a "new synthesis"? Let us consider each of his four elements in turn:

1. The holistic and reflective model of work seems like a potentially powerful extension of "sociotechnical systems" theory and "job enrichment" practices — but one that is more applicable in much less repetitive tasks than we find in direct labor in auto assembly.
2. Uddevalla's ergonomic improvements should be ap-

plicable in many settings — whatever the production system being used.

3. The effort to make work more compatible with non-work life is mentioned in Berggren's list, although it is not discussed in the text. We agree that the leanness of the head count at the Toyota plants probably creates what could be called "presenteeism" — the opposite of absenteeism — that is, a tendency to subordinate workers' nonwork lives to the demands of production. But we should be careful to distinguish between the different variants of the Toyota system. As we noted in our original article, NUMMI was designed as a more humanistic variant, if only to accommodate an older and more militant labor force. Berggren continually confuses Toyota's Japanese operations — concerning which we share some of his criticisms — with the NUMMI operation. Our argument was about NUMMI, not all Toyota operations.

4. The high level of involvement by unions in decision making and planning at Uddevalla was very impressive — but the NUMMI case shows that the Toyota system can deliver world-class results when implemented in a unionized setting with extensive union participation.

The conceptual and empirical issues raised in this debate are complex. Our own provisional conclusion is twofold: first, that many of Uddevalla's accomplishments are of great potential value; but second, that NUMMI's "democratic Taylorist" model of work organization is likely to provide a more robust model for the foreseeable future of labor-intensive volume production. In our original article, we argued that the Toyota system is evolving, as are the alternative systems. We did not argue and do not believe that the Toyota system as represented in any plant or as depicted in any text is the definitive solution. Even if we are right in thinking that some variant or other of the Toyota system is the most

likely path forward, that system could benefit considerably by incorporating some of the features of Uddevalla. Unfortunately, Uddevalla was closed before we could be sure which features were most valuable. ♦

References

1. The IMVP data are taken from J. Womack, D.T. Jones, and D. Roos, *The Machine That Changed the World* (New York: Rawson Associates/Macmillan, 1990), Figures 4.3 and 4.5. These data need to be adjusted to exclude salaried personnel and welding and paint operations, which are not included in the Uddevalla figures. Absent any more detailed information, the IMVP data have been adjusted by prorating indirect labor hours to final assembly in proportion to the share of final assembly in the overall plant operations. The resulting 54 percent figure is the average for the total worldwide luxury and volume producer samples. Regions differ by only plus or minus 3 percent. The Uddevalla data have in turn been adjusted for the presence at Uddevalla of exhaust and door subassembly operations (which were excluded from the IMVP data), for the Volvo 940's relatively large size, and for its high option content. These adjustments were based on our estimates of Volvo production and on the worldwide IMVP sample averages. Together they reduce Uddevalla's hours by 3.6. These are further adjusted for total absenteeism, reducing Uddevalla's hours by another 20 percent. This adjustment is made by IMVP so that comparisons reflect the number of people actually involved in building cars on an average day, not the total number of people on the payroll. This makes allowance for factors beyond the control of plant management that might explain absenteeism, such as national social welfare policies regarding health-related absences. This adjustment may be overly generous to Uddevalla, since one of the goals of its holistic work design was to make work so attractive and interesting that absences would be greatly reduced.
2. K. Ellegård et al., "The Development of Unique Production and Work Structuring Principles Through a Creative Search and Learning Process: The Volvo Uddevalla Final Assembly Plant" (Brussels: EU-ROTECNET Technical Assistance Office, Commission of the European Communities, Task Force on Human Resources, Education, Training and Youth, 1992), p. 14.

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