High-Performance Manufacturing: Evidence from the Automotive Components Industry

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Organization Studies 1997 18: 783
DOI: 10.1177/017084069701800504

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Abstract

This paper examines the manufacturing performance and management practices of 71 automotive components suppliers located in Europe, Japan and North America. The research reports on the extent to which these plants have adopted 'lean production' practices and tests the proposition that such techniques are linked with high manufacturing performance. The results support the contention that tight process control and closely integrated operations are more productive. However, the data do not support the notion that the work organization and human resource policies associated with the lean production model represent a universal 'best way' for achieving high manufacturing performance. Rather, our findings emphasize the importance of context, specific plant characteristics and choice for understanding the performance of manufacturing organizations.

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Descriptors: manufacturing performance, benchmarking, lean production, auto-components, work organization, human resource management, supply chains

Introduction and Issues

This paper examines the hypothesis that lean production practices necessarily lead to high manufacturing performance and contributes to the emergent literature that attempts to establish the empirical relationship between organizational practices and performance (Arthur 1992; Huselid 1993; 1995). Specifically, the paper reports on research into the performance and management practices of 71 'first tier' automotive component plants (33 seat plants, 20 brake-caliper plants and 18 exhausts plants) based in Europe, North America and Japan. The research represents, both in scale and approach, an opportunity to test the prescriptions of the lean production model put forward by the influential International Motor Vehicle Program (IMVP).

The term 'lean production' arose from the IMVP's study of 62 automotive assembly plants and the findings were popularized by the *The Machine That Changed the World* (Womack et al. 1990). The theoretical basis of lean production and its link to high performance has been advanced by MacDuffie (1991, 1995). MacDuffie (1995) argues that an 'organizational logic' of lean production underpins three generic collections or bundles of

Organization Studies
1997, 18/5
783–798

0170-8406/97
0018-0023 $3.00

organizational practices. These are: factory practices (related to the minimization of buffers, for example through the reduction of inventory levels and minimization of repair space), work systems (related to teamwork and the development and application of employee knowledge and skill on the shopfloor) and human resource management (HRM) practices (concerning the encouragement of high commitment and motivation of the workforce). A central claim made by 'lean' proponents is that manufacturing performance in the form of labour productivity and product quality is dramatically improved by the synergistic pursuit of these 'lean' production practices in conjunction with flexible multi-skilling work systems and high commitment human resource policies (Womack et al. 1990; MacDuffie 1995). Furthermore, lean-production management practices are advanced as a *universal* set of best practices which yield performance benefits at the establishment level, regardless of context and environment.

The following issues are raised by this analysis. First, are the IMVP findings applicable to other industry sectors? If lean production is universally applicable then we would expect it to apply to a closely related sector such as auto components where the car assemblers themselves have 'encouraged' their suppliers to improve their performance (Turnbull et al. 1993). A further factor which suggests the appropriateness of examining this sector is provided by Abo (1994) who suggests that lean or Japanese-style management and production systems have been more enthusiastically adopted by the car-parts makers than the assemblers themselves.

Second, the IMVP research suggests that management practices at the plant level are the most important drivers of manufacturing performance. This raises questions about the importance of more traditional explanators of performance such as the scale of operations and regarding the plant's environmental context. Furthermore, the influence of a plant's suppliers and customers on manufacturing performance remain under-explored in the IMVP analysis.

To test the lean production thesis and assess its applicability outside the car assembler sector, we undertook a detailed survey of 71 autocomponents plants between September 1993 to August 1994. This included taking measures of manufacturing performance and management practices such as the factory practices, work systems and HRM policies. To ensure that questions were answered in a consistent fashion, two members of the research team returned to review each question with plant management (see Delbridge et al. 1995a). A sub-set of 13 high performing plants were then identified and the performance and practices of these top performers were contrasted with the other plants in the sample. In addition, our method extends the work of the IMVP by incorporating inter-organizational relationships between these 'first tier' component suppliers with their respective customers (the car assemblers) and suppliers (the 'second tier') and assesses the impact of important plant characteristics such as production scale, capacity utilization and automation.

Overall, the findings provide some support for certain aspects of the lean production model. In particular, the high performing plants exhibit 'process discipline and control' i.e. they employed lean factory practices such as the use of low buffers that include an emphasis on right first-time production and logistical arrangements that require components and products to be delivered and produced just-in-time. However, the data do not show a necessary relationship between high performance and the pursuit of lean work systems and HRM policies such as team working, high involvement in problem-solving activities, extensive induction and the use of sophisticated selection techniques. Rather, the sample of high-performing plants form two distinctive sub-sets: a set of Japanese located and owned high performers demonstrate a close fit to lean work systems and HRM policies, while a set of Western high performers pursue a variety of work systems and HRM practices to equally good effect. Furthermore, the data show that high-performing plants exist within high-performing supply chains where, for example, suppliers provide them with better quality and on-time deliveries and customers provide them with more stable production schedules. Lastly, the plant's characteristics also provide a partial explanation for differences in performance, with the high-performing plants appearing to derive performance benefits from economies of scale and by operating near to their capacity.

These results lead us to conclude that the performance benefits of lean production as portrayed by the IMVP may not necessarily be universally applicable and that certain elements of the model, namely lean factory practices, appear to have closer relations with performance than other aspects. Furthermore, the fact that the high-performing plants benefited from better customer/supplier relationships highlights the limitations of studies which focus exclusively on plant-level practices and suggests that the wider context in which plants operate have a crucial bearing on the plant's manufacturing performance. In turn, this raises a deeper question about how to determine high performance and which measures to take in order to make useful comparisons, a subject to which we now turn.

Determining High Manufacturing Performance

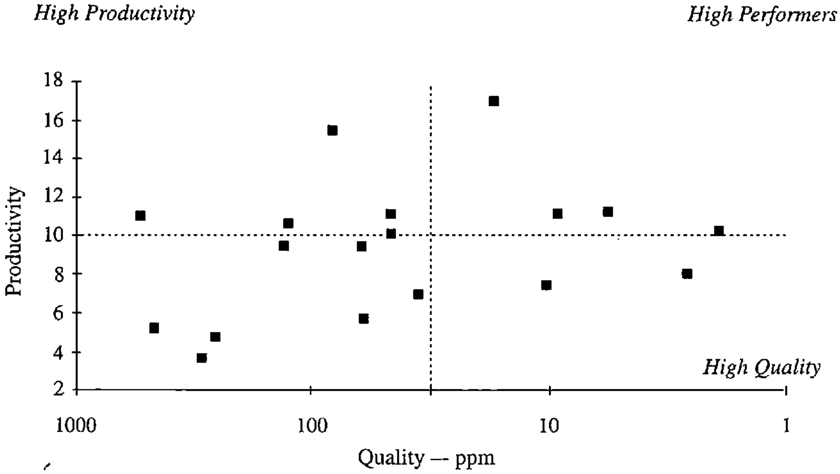
In order to test the lean hypothesis, it is necessary to identify plants that are high performers. As with the IMVP, our definition of high manufacturing performance was in terms of physical productivity and quality at plant level rather than through financial measures of organizational performance. Physical performance measures provide more robust comparisons, as they are less prone to short-term fluctuations (e.g., in exchange rates) and the differing accounting procedures which affect financial measures.

Great care is needed when comparing the performance of manufacturing plants to ensure that the comparisons are accurate. In the case of quality, the measure used was the number of units claimed by the customer (i.e. car assembler) to be defective over a 12-month period recorded as a proportion of total output in parts per million (PPM). While this measure can be criticized on the grounds that different customers may have varying quality standards, the measure has the universal merit of representing the ability of the plant to meet its customers' expectations of quality.

The labour productivity measure used was the average number of units produced per labour hour over a 12-month period. To establish meaningful comparisons between plants, some account has to be taken of differing levels of vertical integration. To control for these variations, productivity was calculated on a set of common core processes performed by each plant within each product area. For example, some seat plants sew their own covers and produce their own foam, so the labour directly associated with these activities was excluded from the labour-input figure in order that only those directly contributing to seat assembly were counted. This has the disadvantage that it is comparing labour input for a smaller part of the value-added content of the product, but is necessary if the comparisons between plants are to have meaning and validity. Furthermore, labour input was measured for strictly defined categories of personnel (directs and others immediately associated with production such as supervisors and materials handlers). All non-working time such as meal times, break times and absenteeism were subtracted, while overtime hours were added. Following this, the annual production output was divided by the total annual labour hours figure to give each plant a 'units per labour hour' productivity measure for the 12-month period. A further adjustment was made for product complexity where statistical tests established a case for doing so.

Having constructed comparable productivity and quality measures, scattergrams of performance were produced for each plant in each product area. In order to identify the plants which were simultaneously high performers on both measures, break lines were plotted at the median value for each measure. Where there was a natural break between plants close to this line, the position line was adjusted accordingly. 'High performing' plants were those which lay above this threshold on measures of both productivity and quality (e.g. see Figure 1). The proportion of plants in each product area

Figure 1
Scattergram of
Brake Plants



which fell into this category was remarkably stable, and for seats was 18 per cent for the total group of seat plants; for exhausts 17 per cent; and for brakes 20 per cent. In total, this procedure identified 13 high-performing plants, comprising six seat plants, four brake plants and three exhausts plants. The following analysis will compare and contrast the characteristics and management practices of these high-performance plants with the other plants in the sample.

Ownership, Location and Performance Differentials

Table 1 provides a detailed breakdown of the sample by ownership and location. By region, nine plants were based in Japan, 18 plants in North America, and 44 plants in Europe. The ownership of these plants was similarly varied, with 16 plants having a Japanese ownership interest, 29 plants with a U.S. interest and 31 plants with European ownership (including part ownership through joint ventures). Unless otherwise stated, the rest of the analysis will refer to the nationality of the plants by location rather than ownership.

Of the 71 plants, 13 demonstrated both high-productivity and high-quality performance. Table 1 below outlines the country in which these plants are located and, respectively, the nationality of their ownership. It shows that the largest concentration of high-performance plants is found in Japan, although, interestingly, only one Japanese-owned plant outside Japan achieves high-performance levels out of a total of seven transplants. The remaining eight high-performance plants were located in the United States, France and Spain and were either U.S. or French owned.

Table 2 overleaf outlines the respective average performance differences between the high-performance plants and the others. The top seat and exhaust plants have a 2:1 productivity advantage compared to the other plants while the top brake plants have a 50 per cent advantage. In terms of quality performance, the differences are even greater. The high-performance seat plants average nine times better quality than the other plants,

Table 1
Location and Ownership

	Total Sample		High Performers	
	Location	Ownership	Location	Ownership
Japan	9	11(5)	5	6
U.S.	13	21(8)	3	3
France	10	11	3	4
Spain	4	0	2	0
Italy	8	8	0	0
Germany	9	4	0	0
U.K.	12	5(1)	0	0
Mexico	4	0(3)	0	0
Holland	0	1	0	0
Canada	1	1(1)	0	0

N.B. Figures in brackets indicate part-ownership in joint ventures.

Table 2
Average Performance Differentials: High-Performance Plants Versus the Others

Performance Measure	Seats		Exhausts		Brakes	
	High performance	Others	High performance	Others	High performance	Others
Productivity (units per labour hour)	1.4	0.7	9.7	4.4	12.5	8.5
Quality (parts per million)	237	2,071	8	1,355	9	144
Internal defect rate (% of total volume)	1.8	2.4	0.7	1.3	0.6	1.4
Space utilization (units per m^2)	34	27	220	100	322	304

while the respective differences for the top exhaust and brake plants are 170 and 16 times greater than the other plants. Furthermore, high-performance plants also have fewer units failing their own internal quality checks and manage to produce more units per square metre of factory space, although the differences on these measures are not as marked as for labour productivity and delivered quality.

The following sections discuss the differences in plant characteristics and management practices that may explain the advantages enjoyed by the top performers.

Plant Characteristics

Three commonly considered factors that may affect productivity are production volumes, capacity utilization and automation. Our evidence substantiates these as offering partial explanations for differentials in manufacturing performance. The production volumes of high-performance plants were typically higher than the other plants, particularly in exhausts, as Table 3 shows. Thus, there appear to be some performance advantages that can be derived from economies of scale.

The high-performance plants also operate with higher labour capacity utilization (given a fixed labour force, the labour-capacity utilization figure indicates any short-fall between what could have been produced and what was actually produced). The differences are more marked between the high-performing seat and brake plants compared to their respective samples, while exhaust plants show similar utilization levels. This contrasts with the automation measures where high-performing exhaust plants are more automated than their counterparts. On average, there is no difference in automation levels for the two groups of brake plants, while in seats the differences are small.

Table 3
Plant
Characteristics
(averages)

Plant Characteristic	Seats		Exhausts		Brakes	
	High performance	Others	High performance	Others	High performance	Others
Production volume (units, 000s)	211	166	4,921	1,194	4,015	2,460
Labour capacity utilization (%)	95	83	87	86	99	83
Automation (% of assembly steps automated)	11	7	52	33	56	56

Process Control

The data presented in Table 4 support the importance of the process discipline and control aspects of the lean production model. It shows that the high-performing plants benefit from greater levels of integration and process discipline, as evidenced by their lower inventories and more frequent deliveries to customers. In the case of seat plants, the average journey time from the supplier to the assembler is half an hour for both sets of plants, yet the high performers deliver twice as frequently and hold only a third of the finished goods inventory. The lower internal defect rates of high-performance plants suggest that they benefit from the discipline that these low inventories and close logistical relationships impose.

Table 4
Inventories,
Logistics and
Internal Quality
(averaged)

Practice	Seats		Exhausts		Brakes	
	High performance	Others	High performance	Others	High performance	Others
Hours of finished goods inventories	2	6	22	28	26	52
Hours of inventories in assembly areas	11	16	26	38	16	40
Frequency of delivery to customer (every x hours)	0.9	1.6	11.9	41.6	14.7	49.3
Final instruction time to assembly	0.3	3.5	12.3	20.7	13.4	15.8
Schedule variability from major customer (%)	2.5	7.0	8.3	6.7	4.4	8.4
Internal defect rate (% of total volume)	1.8	2.4	0.7	1.3	0.6	1.4

The ability to achieve tighter co-ordination of internal processes is partly explained by the more stable schedules which the customers of the high performers provide when compared to the other plants. Fluctuating schedules can be disruptive to production, but as the lower 'instruction to assembly' times (i.e. the length of firm production orders in assembly) indicate, high-performance plants are also able to respond more quickly to changes requested by their customers. This measure partly reflects the better throughput performance of the high performers, with the difference being particularly marked in the brake plants: the high-performance plants take an average of just 11.2 hours (one fifth of the time for the other brake plants) for raw materials to be machined, plated, fully assembled and delivered to the finished goods store.

Work Organization

The role and use of team working is an important element of lean production (Womack et al. 1990). Organizing work activities into teams provides a number of claimed advantages (see, e.g., Tidd 1994; Wickens 1987): it improves the dissemination of information through team briefings, encourages workers to rotate between jobs within the team, and to monitor and highlight the quality defects of their peers. In addition, these teams can be used as a focal point for the organization of problem-solving activities. We found four generic group structures in our study, as shown in Table 5. These data show that all the high-performing Japanese plants had team structures with the team activities co-ordinated by a team leader. Of the eight Western high performers, only two had this form of work organization. Furthermore, just under a third of the non-high-performing plants had a team with team-leader structure, demonstrating that the use of teams does not necessarily guarantee high manufacturing performance. This point is further underlined by the fact that four of the Western high-performing plants do not have a recognizable team structure.

A further feature of the lean production model is the notion that high levels of responsibility are focused on workers to ensure that production problems are dealt with promptly (Womack et al. 1990). To assess the extent to which responsibilities were located on the shopfloor, our questionnaire asked respondents to assign values to reflect the relative responsibility of workers, team leaders, specialists (including skilled workers) and management for a

Table 5
Team Working

	Team with Team Leader	Team without Team Leader	No Team Structure	In Transition
High performing Japanese plants	5	0	0	0
High performing Western plants	2	1	4	1
Other plants	23	5	23	7

collection of key work activities. These data are presented in Table 6 for workers and team leaders only. The 'quality' category encompasses responsibility for rework, quality improvement and inspection. 'Manufacturing' includes the averaged responsibility for scheduling, allocation of tasks, pace of work and process improvements. 'People' covers hiring, dismissal, grievance handling and training.

The data here do not support the argument that high manufacturing performance is associated with the devolution of responsibility to line workers. There are no consistent differences between Western high performers and the other plants in the study. However, the Japanese high-performance plants are clearly differentiated from the rest of the sample in having higher levels of responsibility focused on to the shopfloor in all the categories except quality. The relatively low score of the high-performing Japanese plants on this measure may indicate the importance of design engineers in ensuring manufacturable products and industrial engineers in fool-proofing the manufacturing process, actually reducing worker responsibility for quality. In any event, this finding is not supportive of the lean production model which would suggest that workers exercise considerable responsibility for quality activities and that they are 'empowered' through greater delegation of these responsibilities.

A noteworthy finding is the distribution of responsibilities between team leaders and workers. In the Japanese high-performance plants, team leaders had two to three times the responsibility of their Western counterparts across all four categories. In the 'people' category, team leaders in Japanese high performers had almost total responsibility for handling grievances and training workers. Conversely, Japanese workers took virtually no responsibility for any 'people management activities'. Part of the explanation for

Table 6
Shopfloor Responsibility (total responsibility = 100%).

	Japanese High Performers (%)	Western High Performers (%)	Other Plants (%)
Quality			
Workers	35	49	51
Team leaders	27	21	20
Total shopfloor	62	70	71
Manufacturing			
Workers	15	16	20
Team leaders	49	16	33
Total shopfloor	64	32	
Maintenance			
Workers	13	12	53
Team leaders	25	9	12
Total shopfloor	38	21	25
People			
Workers	1	14	8
Team leaders	45	17	23
Total shopfloor	46	31	31

the team leaders' high involvement in training concerns the propensity of these firms to carry out in-house, on-the-job training. This suggests that the team leaders in these plants play an important role in ensuring worker competence and compliance and helps to account for the higher levels of supervision and tighter spans of control present in these Japanese plants, when compared to other plants. There is an average of 6.7 operators per team leader/supervisor in the Japanese plants compared to 10.9 in the United States and an average of 17.7 in the Continental European plants (see Delbridge et al. 1995b).

Suggestion schemes and problem-solving activities represent both individual and collective mechanisms for capturing worker knowledge and thereby improving the quality of the product and manufacturing process. They therefore form an important element of the lean production model, as it is through such activities that workers overcome the potential problems of a low buffered system and contribute to organizational learning. All the Japanese high performers had suggestions schemes and 80 to 90 per cent of Western plants also had such schemes. However, as Table 6 indicates, the scope and operation of these schemes varies. The Japanese high-performance plants obtain substantially higher numbers of suggestions per worker, implement a larger percentage of these suggestions and involve a larger percentage of their workers in their schemes, despite offering much lower financial reward per suggestion. The Japanese results are partly explained by the use of formal individual targets for suggestions against which performance is assessed and rewarded via appraisal and merit increases in workers' salary. This also helps to account for the wider involvement of workers in problem-solving activities. Outside Japan, high-performance plants involve a larger percentage of their workforce in both problem-solving activities and suggestion schemes but this does not yield many suggestions per head. Furthermore, the frequency and duration of problem-solving group activities does not differ substantially between the Western high-performance plants and the rest of the sample. While problem-solving activities and suggestions have historically been 'voluntary' activities for Western workers, in Japan they form part and parcel of the formal job duties of shopfloor workers. The widespread take up of team structures and problem-solving activities, particularly in the United States and the United Kingdom, suggests that such activities are also increasing the formality of Western workers' labour process (Delbridge et al. 1995b).

Overall, the data presented in this section show that Japanese high-performance plants operate a distinct model of shopfloor organization which involves team working, high levels of team-leader responsibility and the active involvement of workers in problem solving and suggestion-scheme activity. However, this does not appear to be the only route for the achievement of high manufacturing performance, as evidenced by the fact that Western high performers do not exhibit substantially higher levels of worker involvement in problem solving when compared to other plants in the study. Nor do they all operate with teams or with a 'high responsibility' team-leader role.

Table 7
Problem Solving and Suggestion Schemes

	Japanese High Performers	Western High Performers	Other Plants
Problem Solving			
Percentage of factory workforce involved	95.4	57.4	37.8
Frequency of meetings (every x days)	8	8 to 9	9
Time scheduled (hours per month)	1 to 2	1 to 2	3
Suggestions			
Number of suggestions per employee	47	1	2
Percentage accepted	70	57	54
Typical value of reward	£23.1	£59.4	£117.5
Percentage of total from workers	84	74	55

Human Resource Issues

As outlined earlier, a compliant and motivated workforce forms a key feature of the lean production model and it has been argued that certain HRM practices provide this. As Table 8 shows, the high-performance plants benefit from more stable workforces, as shown by the longer average years of service and lower labour turnover. Absenteeism is also lower in the high-performance plants, but only marginally so when comparing Western high-performance plants with their counterparts. However, little separates the plants in terms of the average age of their workforces.

When considering the links between HR practices and high manufacturing performance there is little evidence which systematically distinguishes the high performers from the rest of the sample. The sophistication of selection procedures was measured, but there were no major differences between

Table 8
HR Profiles

	Age of Employees (years)	Length of Service (years)	Labour Turnover (%)	Unscheduled Absenteeism (%)
Japanese high performers	35.0	12.7	3.7	0.2
Western high performers	33.5	10.2	2.6	4.3
Other plants	33.2	7.5	6.1	4.7

the high-performance plants and the rest. Furthermore, comparisons of induction processes between the plants showed no significant differences between Western plants, but the Japanese high performers spent comparatively more time inducting their workers, gave them a longer probation period and also lost fewer workers at the end of their probation.

It has been argued that lean production requires the marginalization and/or incorporation of trade-union organization (Garrahan and Stewart 1992). Most of the plants recognized trade unions and the majority of high-performance plants were union organized. High-performance plants did appear to involve their unions in a wider range of decisions than the other plants although these data are based on managerial perceptions of union involvement and do not indicate the level of effective influence that this involvement brought.

In terms of remuneration, the lean production model would suggest that pay should be related to performance as a means of encouraging worker motivation and involvement in organizational activities such as problem-solving groups (MacDuffie 1995). In the Japanese high-performance plants this practice seemed to apply, with workers' pay determined by a combination of skills learned and merit awards based on individual performance. However, in Western high performers it was more usual to pay operators by their job classification and/or seniority. Furthermore, half of the Western plants pay a supplement according to skills learned, and half offer a bonus related to plant performance. This finding once again suggests some ambiguity about the role of performance-related pay in achieving its objectives (Kessler and Purcell 1992).

Discussion and Concluding Remarks

This paper has examined the performance and management practice characteristics of a sample of automotive components located in Europe, Japan and North America. Of the 71 plants studied, 13 were able to combine high labour productivity with high delivered quality when compared to other plants in their respective product areas. There were examples of high-performance plants located and owned in each geographical region. The paper has been concerned to establish what features of these plants may explain their relatively high manufacturing performance and to test the hypothesis that lean production practices lead to high performance. The evidence is mixed.

The data show that part of the explanation for the higher performance of top plants lies with some combination of scale (volumes), capacity utilization and automation. In particular, the high-performance exhaust plants tend to be much larger than the average and are also more automated, while the high-performance seat and brake plants enjoy higher levels of capacity utilization. This suggests that some traditional manufacturing imperatives are still important determinants of high manufacturing performance. Indeed, these findings suggest that the plants gain some performance benefit from pursuing traditional manufacturing objectives (particularly those involving volumes and automation). This leads us to question whether the conceptual contrasts between lean and mass production have been exaggerated and to conclude that lean production does not negate some of the traditional correlates with high productivity, such as economies of scale.

With regard to the lean production model, there is evidence that lean factory practice does contribute to high manufacturing performance. The data presented here demonstrate the importance of process control which is integrated across the manufacturing system and through the supply chain. The high-performance plants exemplify this 'process discipline and control' through the integration and coordination of internal manufacturing processes with right first-time production and low inventories, tight schedules and the rapid flow of materials from suppliers through the plant and on to the customers.

However, the data with regard to work organization and HR practices fail to offer convincing support for the universal applicability and efficiency of the lean production model. There is mixed evidence on the use of teams, with a number of high-performance plants operating successfully without a recognizable team structure and a large number of plants with teams failing to perform to the highest standards. Similarly, there is little to suggest that high performance is necessarily concomitant with the devolution of responsibility to highly skilled, 'empowered' line workers who actively engage in continuous improvement and problem-solving activities.

In fact, our data suggest that there may be two sub-groups among the high-performance plants. The plants which do demonstrate management practices in line with the lean production hypothesis are the Japanese high performers. These plants distinguish themselves from Western plants with the more pervasive operation of their suggestion schemes, evidenced by wider involvement and implementation of operators' suggestions. All of the Japanese plants (high and low performing) operate with a team structure, engage in group problem-solving activities and are distinguished by the relatively high levels of responsibility placed with team leaders. There is little support for the lean production hypothesis relating to the expansion of employee involvement, enhanced skill and heightened commitment outside these Japanese plants. While these features may improve a firm's performance, they do not appear to be a defining characteristic in all plants achieving high manufacturing performance.

The finding that the lean production model was widely pursued by all the Japanese plants, regardless of their relative performance, raises further questions about the importance of location and ownership as explanatory factors of both the performance and management practices pursued by the manufacturing plants in our sample. A detailed discussion of the implementation of lean production practices across the different countries we studied is not possible here (for this, see Delbridge et al. 1995b; Oliver et al. 1996). Nevertheless, on the basis of the data presented in this paper, we would argue that nationality of ownership does not appear to be a determinant of performance. Our data show that high performing plants were owned by Japanese, American and French companies and that, while the largest concentration of high-performance plants was found in Japan, only one Japanese transplant achieved high-performance levels, out of a total of seven. With regard to location, our sample shows a wide range of performance within each country and demonstrates that the importance of location lies at the inter-organizational level, with performance affected by interactions with various institutions including suppliers and customers (i.e. high-performance plants are part of high-performing supply chains).

These findings raise two important questions over research into organizational practices and high performance: (i) To what extent can lessons be drawn from one industry and transposed to others?; (ii) To what extent can individual organizations be treated as independent of, rather than mirrors of, their institutional context?

In contradistinction to the universalistic proposals of MacDuffie (1995) and Womack et al. (1990), our data emphasize the differences which persist among groups of plants from different product areas, with different customers and operating in different locations. While the data suggest that there may be generic competitive advantages from operating with technical systems that have low buffers and produce right first-time, the social systems which support this may be highly varied. This conclusion is in line with other recent research that has suggested that simple contrasts between competing organizational logics are not reflective of empirical findings (Elger and Smith 1994). Our findings suggest that any link between lean production and manufacturing performance may be severely restricted outside plants operating in the auto assembly sector and/or in Japan.

These conclusions indicate that a further methodological consideration is important in studying organizational performance and practices. Our research into the impact of the organizations' relations with suppliers and customers indicates the limitations of research focusing entirely at the individual establishment level. The failure to incorporate an examination of the wider context and macro-environment of the organization has also been a major part of the critique of lean production to date. It has been suggested that important contextual material such as market structure and historical performance have been obscured by the proponents of lean production (Williams et al. 1994). In the view of these authors, the neglect of these issues has led the performance differential between lean and non-lean organizations to be exaggerated.

Even MacDuffie's (1995) success at apparently linking organizational performance to management practices leaves much unexplained. Our data concerning the plants' relationships with customers and suppliers indicate that some of their manufacturing performance can be accounted for by the quality performance, scheduling and logistics of these actors. In effect, high-performance plants benefited from being located in high performance supply chains and this was demonstrated by tighter logistical relationships and fewer quality defects passed on from suppliers to the plant and then on to the customer. This finding raises a hitherto largely over-looked phenomenon in much of the recent research into organizational practices and performance — that better understanding of organizational performance can be achieved not by a focus on single organizational units (such as manufacturing plants) but by studies which attempt to assess value chains comprised of linked organizational units. A pursuit of this line of investigation would not be without its conceptual and empirical difficulties yet our data show, albeit in a limited way, the potential for understanding the organization's performance in a wider context which includes an embedded set of relationships at least with customers, suppliers and workers.

Note

* The authors gratefully acknowledge the sponsorship of Andersen Consulting and the contribution of Isabelle Dostaler, Dan Jones, Gillian Hunter, Nick Rich, Sandra Rutherford, Paul Ryan and Gianni Zappalà to the *Worldwide Manufacturing Competitiveness Study.*

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