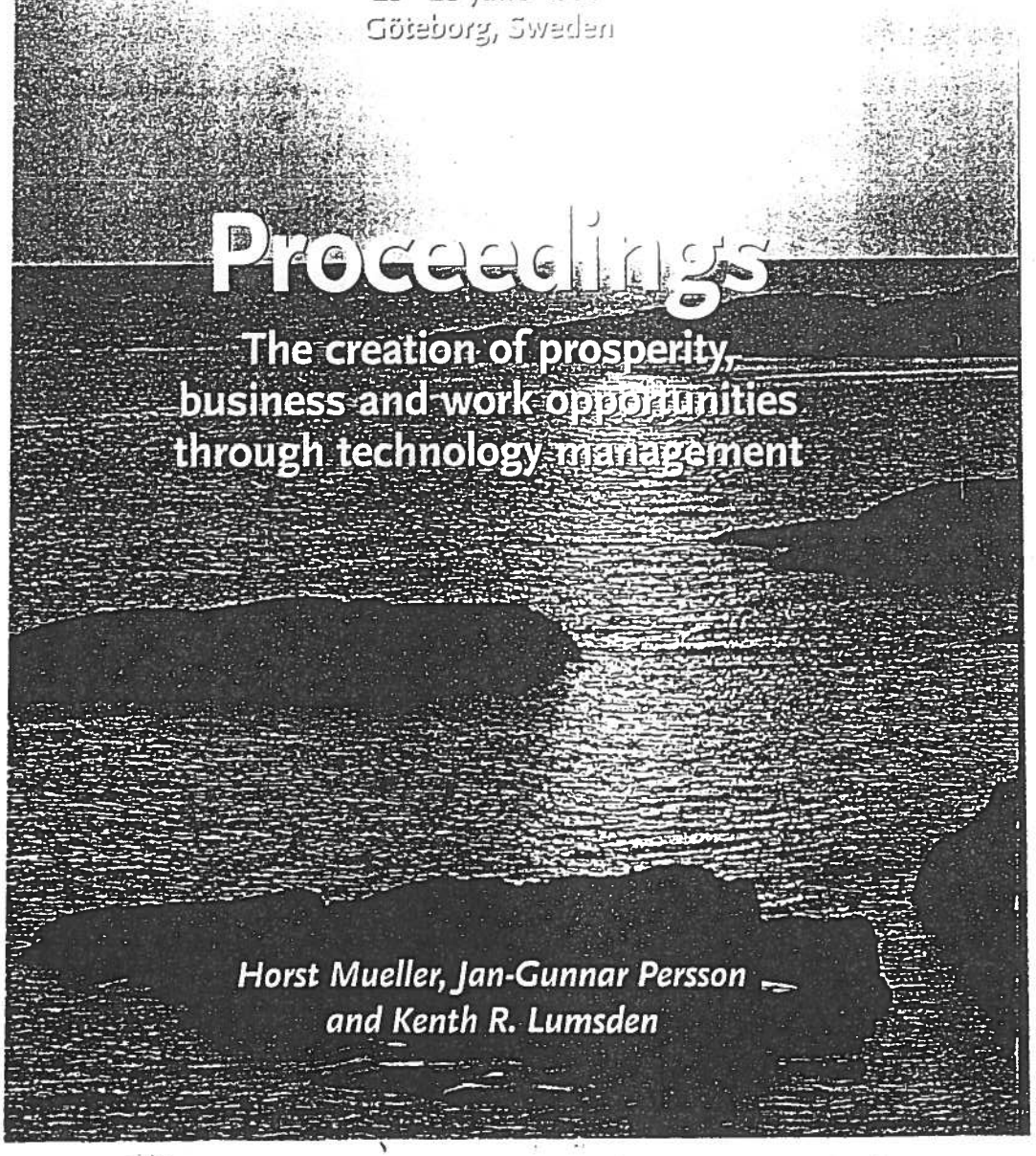
THE SIXTH INTERNATIONAL
CONFERENCE ON
MANAGEMENT OF TECHNOLOGY
MOT 97

25–28 June 1997
Göteborg, Sweden



Proceedings

The creation of prosperity, business and work opportunities through technology management

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Production Models and Social Contexts

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ABSTRACT

This paper discusses production models for final assembly in the automobile industry. Some issues and pitfalls in current production model discourse are briefly considered, and in this context a distinction between manufacturing models and broader industrial models is introduced. Drawing on this distinction, we discuss the Japanese "Lean production" as an industrial model and the impact of socio-economic and socio-cultural contexts on manufacturing models and industrial models.

Based on data on labour's share of value-added as related to value-added's share of sales, we argue that the competitive advantage of Japanese automobile manufacturers may be due rather to the strength of Japanese "Lean production" as an industrial model than to its efficiency as a manufacturing model. Specifically, assembly plant productivity and assembly plant practices do no warrant the amount of attention paid to them recently (e.g. by Womack et al. 1990), whereas, as our analysis implies, supplier relationships may be a key issue.

Additional factors that have to be taken into account in the current production model discourse are prevailing societal values such as the reputed Japanese "hardship mentality" and the corresponding values in "post-industrial" societies such as Sweden. For example, in the Swedish Uddevalla and Kalmar plants we found that the most important determinants of job satisfaction were perceived opportunity to exert influence over one's own work and whether one's work was perceived to be interesting, providing opportunities for personal growth. By contrast, workers' evaluation of the pay received, for example, was not a significant determinant of work satisfaction. Clearly, the manufacturing model used must agree with predominating societal values; for example, few assembly workers in the Uddevalla plant would probably have felt happy with traditional assembly line work.

The analysis in this paper indicates that it is more interesting to look for those conditions that allow big wage differentials between suppliers and assemblers to exist than to look for assembly plant practices that allow assembly plant man-hour counts to be reduced. In this connection, attention should be directed at the Japanese company union system and the core company – core employee alliance in the Japanese automobile industry.

1. Introduction

During the last decade, management's search for profitability and other elements of business success seems to have taken a new turn. The business strategy perspective has been de-emphasized in favour of a production model perspective.

In the business strategy perspective, the design of manufacturing operations are regarded as involving a number of trade-offs between performance aspects, e.g. a trade-off

between productivity and product quality. The choice of manufacturing strategy reflects the priority assigned to various performance aspects, e.g. whether productivity is given priority over product quality. The priorities and the manufacturing strategy chosen ideally depend, in turn, on the contingencies characterizing the current situation, including the type of products manufactured, the broad business strategy adopted by the company and its business environment. A manufacturing strategy that is appropriate in one context would be inappropriate in another context according to this line of thinking.

According to the current production model discourse, by contrast, manufacturing operations should be designed in accordance with a production model that tends to be regarded as generally applicable and superior in all respects. Trade-offs between different performance aspects are de-emphasized. For example, it is believed that there is no real contradiction between productivity and product quality; they can be improved simultaneously by applying appropriate production methods – that is, by emulating a universally valid production model. Thus, the precepts of "World Class Manufacturing" are presumably valid in all contexts.

Clark (1995) points out that the shift to a production model perspective has been inspired by Japanese manufacturers' market success during the seventies and eighties. This market success seemed to derive from a superior production competence rather than a clever choice of business strategy.

The management best-seller "The Machine that Changed the World" (Womack et al. 1990) explicitly linked the competitive advantage of Japanese automobile manufacturers to a specific production model pioneered by the Toyota Corporation, so-called "Lean production". A basic explanatory model proposed in this book is summarized in Figure 1 (Jonsson 1995).

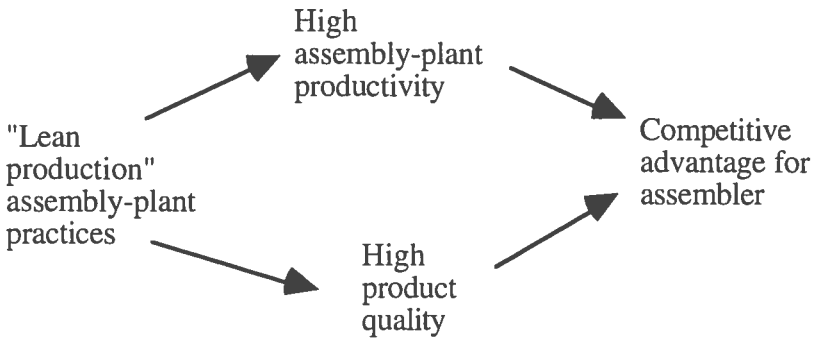

Figure 1. Summary of causal analysis of Japanese automobile assemblers' competitive advantage according to Womack et al. (1990).

As explained in some detail by Jonsson (1995), this explanatory model is unsatisfactory for several reasons. Most important in the present context is the fact that the model is incomplete. The point is that the assembly plant represents only the tip of the iceberg in the automobile industry. It is a great analytic mistake, therefore, to focus on assembly plant practices and performance, neglecting the broader industrial system "beneath the surface" and the relevant social context.

This paper may be viewed as an attempt to clarify, criticize and extend the current production model discourse, using the automobile industry as an illustration.

2. Some issues and pitfalls in the current production model discourse

The notion of a production model represents a theoretical abstraction from and simplification of actual industrial practices. It may be questioned whether such ex post schematizations and categorizations of complex, disparate and constantly changing industrial practices do really clarify issues. Some problems involved will be illustrated by the case of "Lean production" or "Toyotism" (cf. Boyer and Freyssenet 1995).

First, it has been questioned whether "Toyotism", and even more so "Lean production", is a well-defined, coherent model. "The Machine that Changed the World" praises "Lean production", but does not really define it. Also, there is no general consensus about what are the essential elements of "Toyotism". The fact that Toyota is now experimenting with new production practices, in particular at the Tahara IV and Kyushu plants (Nomura 1993, Benders 1994), highlights this lack of precision. Does this mean that Toyota is now using two production models simultaneously, or does it mean that one production model is changing into another one, or is this a change within the scope of the same production model?

Second, while Womack et al. (1990) contrast "Mass production" to "Lean production", others (e.g. Warnecke and Huser 1993) have seen more continuity than change. "Lean production", after all, retains key elements of traditional "Mass production" such as the paced assembly line, short cycle times, standardised work methods and a hierarchical organisation structure.

Third, there is a frequent confusion about levels of analysis in the current production model discourse, as suggested by some authors' change of vocabulary from "Lean production" to "Lean enterprise". The question is whether "Lean production" or "Toyotism" should (1) be regarded as a production model in the narrow sense, i.e. a schematization of assembly plant practices, or should (2) be understood as including design, component supply, marketing, finance etc. For example, Womack et al. (1990) vacillate between these two interpretations in a confusing manner.

To emphasize this important distinction between levels of analysis, production models in the narrow sense will be referred to as manufacturing models in the remainder of this paper, while production models in the broader sense will be referred to as industrial models.

Another significant problem in the current production model discourse is distinct from but related to the mainly conceptual problems just considered. This is the problem of causal misinterpretations of performance differences. Specifically, inter-firm differences with respect to physical and economic performance measures are frequently erroneously attributed to differences between manufacturing models rather than differences between products, differences between industrial models, differences between social contexts, etc.

In particular, the cost contribution of assembly plant man-hours is not sufficient to merit the amount of attention paid to them by Womack et al. (1990). In a Swedish final assembly plant recently studied, the labour costs amounted to less than 10 percent of the costs for materials alone. Even though labour costs for welding and painting of bodies have to be added to this figure, the labour costs in the assembly plant amounted to only about 5 percent of total production costs. Similarly, Mishina (1995) reports that in Toyota's Kentucky plant labour accounts for only 7 percent of manufacturing costs. These figures indicate that even if labour costs in the assembly plant are reduced dramatically, the resulting total cost reduction will be marginal, and this marginal cost reduction cannot reasonably account for the huge market success enjoyed by Japanese automobile manufacturers up to the early 1980s.

In a broader perspective, on the other hand, there are many significant elements of the total production costs that may favour Japanese automobile manufacturers. Especially during the 60s and 70s, the main expansion period for the Japanese automobile industry, lower domestic wages -- especially among suppliers – also created a cost advantage. As late as 1980, Japanese labour costs in the motor vehicle sector were only 58 percent of those in the US (Williams et al. 1994). In 1989, Japanese motor industry firms with less than 100 employees – a category where the lower echelons of suppliers are found – paid wages equal to only 53 percent of those in the largest firms (Williams et al. 1994).

Ironically, statistical data suggest that the productivity in the Japanese motor vehicle industry was lower than that in the United States at least until the mid-1970s (Williams et al. 1994). Nevertheless, the Japanese share of the world motor vehicle market increased from 1.3 percent in 1960 to 18.1 percent in 1975. On the other hand, the Japanese share of the world motor vehicle market has not grown since about 1980, despite the productivity advantage presumably existing lately.

3. "Lean production" as an industrial model

Observations such as those reported above suggest that the competitive advantage of Japanese automobile manufacturers may be due more to the strength of Japanese "Lean production" as an industrial model rather than its efficiency as a manufacturing model. As a further illustration of this theme, we shall consider some data on labour's share of value-added as deduced from company reports.

Company reports indicate that labour's share of value-added is smaller in Japanese automobile companies (Toyota, Mazda, Nissan and Honda) than in American and European companies. This could of course be interpreted as evidence of higher productivity in Japanese companies, i.e. evidence of superior performance of "Lean production" as a manufacturing model. Further analysis of the data shows, however, that labour's share of value-added is also strongly correlated with value-added's share of sales, and that these shares are smaller in Japanese automobile companies than in non-Japanese companies.

Figure 2 shows that for Japanese and non-Japanese automobile manufacturers alike, labour's share of value-added tends to decrease as value-added's share of sales decreases. Further analysis reveals that the correlation between the national affiliation of the automobile manufacturer and labour's share of value-added vanishes almost entirely when value-added's share of sales is kept constant. According to the path analysis in Figure 3, using the same data as in Figure 2, the national affiliation of the automobile manufacturer is not per se a significant determinant of labour's share of value-added.
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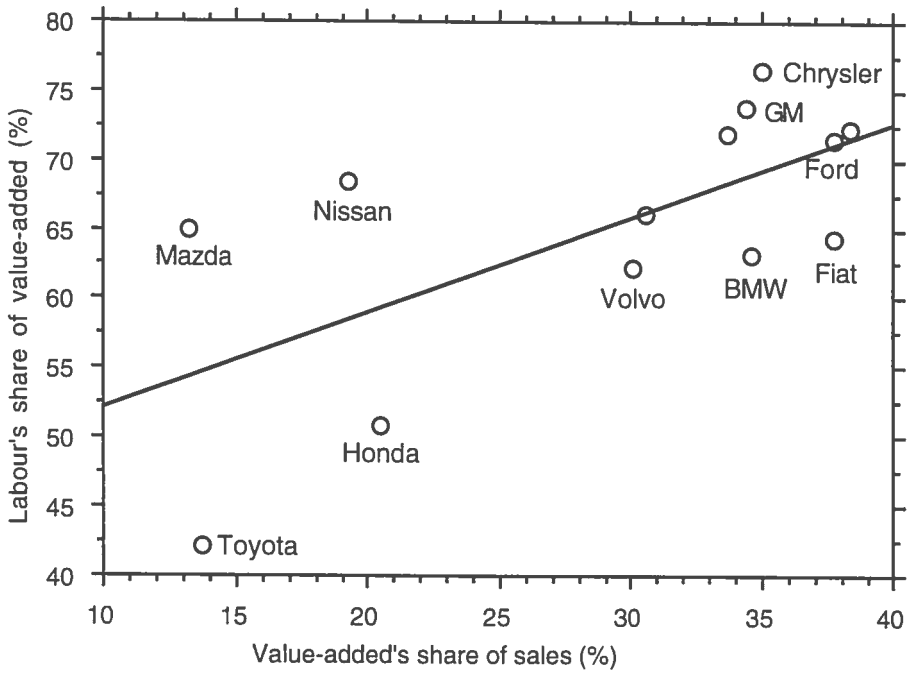

Figure 2. Plot of value-added's share of sales and labour's share of value-added for 13 automobile manufacturers. Mean values for a ten-year period (1981 – 1990).
Source : Value-added's share of sales: Williams et al. (1994); labour's share of value-added: Williams et al. (1994).

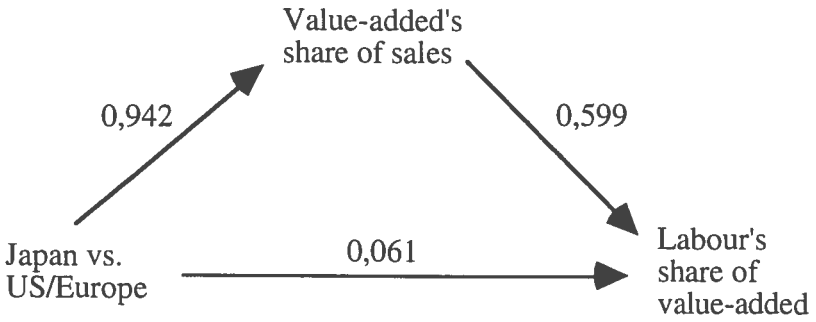

Figure 3. Path analysis based on correlations between (a) national affiliation of automobile company (Japan vs. US/Europe), (b) value-added's share of sales and (c) labour's share of value-added.

It may be asked, of course, why labour's share of value-added tends to decrease as value-added's share of sales decreases. This can be explained in substantial as well as mathematical terms.

The substantial explanation hinges on wage gradients in supplier networks. Cusumano (1985) estimates that Nissan and Toyota each controls roughly 200 subsidiaries and primary contractors, who in turn employ about 5 000 secondary subcontractors and some 30 000 tertiary subcontractors. Many secondary and tertiary subcontractors are quite small companies. As noted above, Japanese motor industry firms with less than 100 employees paid wages equal to only 53 percent of those in the largest firms in 1989. Cusumano (1985) points out that even the largest subsidiaries of Nissan and Toyota paid lower wages than the parent firms. During the fiscal year of 1989 the average monthly income in 15 of Nissan's major subsidiaries was only 81 percent of the wages at the

parent company, while average monthly income in 10 of Toyota's major subsidiaries was only 79 percent of the wages at the parent company.

It seems safe to assume that the average ratio of supplier to assembler wages in the Japanese automobile industry did not exceed 70 percent. Furthermore, the 70 percent wage gradient has been reported to apply to Japanese automobile industry supplier networks in the United States (Kenney and Florida 1993). The bottom line is that, given this wage gradient, profits can be increased simply by moving work from the assembler to its suppliers, substituting cheap labour for expensive labour. And as profit's share of value-added increases, labour's share of value-added decreases.

Table 1 provides a numerical illustration of the fact that labour's share of value-added for the assembler tends to increase when relative wages in supplier firms increase. The hypothetical values in Table 1 reflect the assumptions (i) that cases (a) and (b) differ from cases (c) and (d) with regard to the extent of outsourcing and with regard to the margin between suppliers' sales revenues and labour costs, and (ii) that cases (a) and (c) differ from cases (b) and (d) with regard to the wage gradient, i.e. the relative wages among suppliers.

Table 1 also illustrates the fact that assemblers who rely extensively on outsourcing are more sensitive to increases in relative wages among supplier firms than assemblers who do more manufacturing in-house. For example, under the assumptions underlying Table 1, an increase of relative wages in supplier firms from 70 percent of that in the assembler firm to 100 percent leads to an increase of labour's share of value-added from 40 percent to 280 percent for an assembler where value-added's share of sales was initially 20 percent, compared to an increase of labour's share of value-added from 60 percent to 72 percent for an assembler where value-added's share of sales was initially 50 percent.

CASE:	A	B	C	D
Sales, industrial system	100.0	100.0	100.0	100.0
Purchase, industrial system	20.0	20.0	20.0	20.0
Value-added, industrial system	80.0	80.0	80.0	80.0
Purchase, assembler	80.0	97.1	50.0	58.6
Value-added, assembler	20.0	2.9	50.0	41.4
Value-added, suppliers	60.0	77.1	30.0	38.6
Labour costs, assembler	8.0	8.0	30.0	30.0
Wage gradient, suppliers/assembler	70%	100%	70%	100%
Labour costs, suppliers	40.0	57.1	20.0	28.6
Value-added - labour costs, suppliers	20.0	20.0	10.0	10.0
Labour's share of value-added., assembler	40%	280%	60%	72%

Table 1. Numerical illustration of the combined effect of extent of outsourcing and wage gradient in supplier network on labour's share of value-added for assembler.

The mathematical explanation of the association between value-added's share of sales and labour's share of value-added, on the other hand, hinges on the observation that when a component is outsourced and bought at cost price, the company's profit is (by definition) not reduced, but value-added is. As a consequence, profit's share of value-added is increased, and labour's share is decreased accordingly. The hypothetical values in Table 2 illustrate the fact that labour's share of value-added tends to decrease as value-added decreases, assuming that the assembler's profit does not change.

CASE:	A	B
Sales, industrial system	100.0	100.0
Purchase, industrial system	20.0	20.0
Value-added, industrial system	80.0	80.0
Purchase, assembler	80.0	50.0
Value-added, assembler	20.0	50.0
Value-added, suppliers	60.0	30.0
Profit, assembler	10.0	10.0
Profit as share of value-added, assembler	50%	20%
Labour's share of value-added, assembler	<50%	<80%

Table 2. Numerical illustration of the effect of extent of outsourcing at cost price on labour's share of value-added for assembler.

Note that the substantial and mathematical explanations of the fact that labour's share of value-added tends to decrease as value-added's share of sales decreases do not exclude each other. Whatever the explanation of the correlation observed, the argument above provides convincing proof that the entire supply chain must be taken into account when evaluating corporate performance. That is, the current production model discourse must be extended to consider the industrial model perspective.

It appears, then, that cause and effect are confounded in the causal model in Figure 1. Rather than being a main cause of competitive advantage, the apparent high productivity in Japanese assembly plants is to a large extent a result of extensive outsourcing. Competitive advantage derives from extensive outsourcing combined with low relative wages among suppliers rather than high assembly-plant productivity. It is also clear that outsourcing is driven by low relative wages in supplier companies.

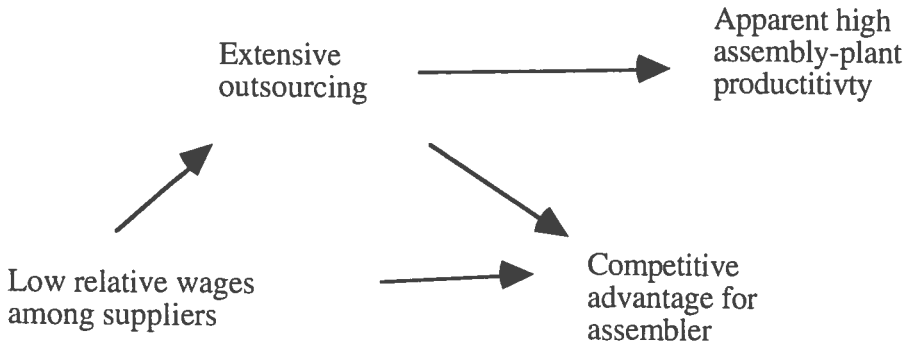

Figure 4. Summary of causal analysis of assembler's competitive advantage in the industrial model perspective.

It should also be noted that the quality of the end product depends to a large extent on the quality of the components assembled. Product quality may thus be due more to the achievements of the suppliers than those of the assembler, especially if extensive outsourcing is practised as in the Japanese automobile industry.

4. Socio-economic and socio-cultural contexts

Yet another level of analysis, pertaining to socio-economic and socio-cultural contexts, should be introduced into the current production model discourse. For example, it may be argued that the growth of world market share for the Japanese auto industry does in part

only reflect the phenomenal growth of its sheltered domestic market -- the number of motor vehicles sold in Japan increased from some 200 000 in 1960 to about 7 000 000 in 1989.

Additional factors that have to be taken into account in the current production model discourse are prevailing societal values such as the reputed Japanese "hardship mentality" (Lillrank 1995) and the corresponding values in "post-industrial" societies such as Sweden.

By way of illustration, let us consider some of our data from the Volvo Uddevalla plant based on a "multi-disciplinary" questionnaire covering psychosocial and technical aspects. This questionnaire was distributed to the subjects during working hours. The subjects were randomly selected and they answered the questionnaire anonymously. The response rate was approximately 90 per cent. The total study included 97 employees including 64 assembly workers out of a total work force of 708 blue-collar and 108 white-collar employees.

Assembly workers were asked for an overall evaluation of their work and workplace, and also described these in a number of respects listed in Table 3. A multiple regression analysis revealed how important each of these dimensions was as a determinant of job satisfaction. As shown in Table 3, the most important determinants of job satisfaction was the perceived opportunity to exert influence over one's own work and whether one's work was perceived to be interesting and provide opportunities for personal growth. By contrast, workers' evaluation of the pay received, for example, was not a significant determinant of work satisfaction.

INDEPENDENT VARIABLE:	Regression coefficient (β)	Standardised regression coefficient
Pay	0.08	0.08
Physical work environment	0.03	0.02
Chance to exert influence over one's own work	0.23*	0.28
How well one is going along with one's work mates	0.07	0.06
Whether one's work is interesting and provides opportunities for personal growth	0.34*	0.45
Whether something of value for others is produced	0.04	0.04

Table 3. Regression coefficients, based on our data from the Volvo Uddevalla plant, indicating to what degree job satisfaction is affected by assessments of work and workplace in various respects. Regression coefficients marked with an asterisk (*) are statistically significant ($p<0,01$).

The Volvo Uddevalla plant might be suspected to represent an aberrant case in view of this plant's youth and its innovative design. A survey carried out by us at the older and more traditional Volvo Kalmar plant gave quite similar results, however. This survey was based on the same "multi-disciplinary" questionnaire as used at the Uddevalla plant (Engström, Jonsson, Johansson 1997). It was performed approximately one year after the Kalmar plant was closed down and included all former employees at the Kalmar plant. The questionnaire was distributed by mail and was returned by 344 employees, corresponding to a response rate of approximately 50 percent.

The only notable difference between the two plants in this regard was that how well one was going along with one's work mates tended to be more important as a determinant of job satisfaction in the Kalmar plant than in the Uddevalla plant (see Table 4).

INDEPENDENT VARIABLE:	Regression coefficient (β)	Standardised regression coefficient
Pay	0.02	0.02
Physical work environment	-0.14	-0.14
Chance to exert influence over one's own work	0.20*	0.29*
How well one is going along with one's work mates	0.23	0.16
Whether one's work is interesting and provides opportunities for personal growth	0.21*	0.32*
Whether something of value for others is produced	0.09	0.12

Table 4. Regression coefficients, based on our data from the Volvo Kalmar plant, indicating to what degree job satisfaction is affected by assessments of work and workplace in various respects. Regression coefficients marked with an asterisk (*) are statistically significant ($p<0,01$).

Given their preferences, few of the assembly workers in the Uddevalla plant would have felt happy with traditional assembly line work. On the other hand, it may be argued that assembly line work is more acceptable in Japan due to the above-mentioned "hard-ship mentality". At any rate, it is obvious that the current production model discourse and the choice of manufacturing model should take dominating societal values into account.

5. Conclusions

The analysis above indicates that it is more interesting to look for those conditions that allow big wage differentials between suppliers and assemblers to exist than to look for assembly plant practices that allow assembly plant man-hour counts to be reduced.

In this connection, the Japanese company union system is of considerable importance. Japanese unions are organized not by industry or trade but by company, and these company unions recruit white-collar as well as blue-collar employees. This system is more conducive to big wage differences between suppliers and assemblers than the industrial union system existing elsewhere, where employees in assembler and supplier companies to a large extent belong to the same union, such as the Svenska Metallindustriarbetareförbundet in Sweden or I.G. Metall in Germany.

The company union system with its close ties between employers and employees is not necessarily a manifestation of Japanese culture, though. Indeed, an industrial union within the automobile industry, the Zenji, was formed in 1947, but it was dissolved in 1954 after being defeated in a fierce labour market conflict involving Nissan, Toyota and Isuzu. Cusumano (1985) comments:

> "Yet the circumstances that led to Zenji's demise suggest that this and other industrial unions were not destined, as a matter of cultural necessity, to fail in Japan. Industrial unions might well have survived had managers and white-collar workers headed for managerial positions not united during the 1950s to break up labour federations and replace them with pro-management, company unions." (p. 138 – 139).

The company union system is thus a cornerstone of what is in effect a core company – core worker alliance in the Japanese automobile industry (cf. Altmann 1995). The close ties between employers and employees in the large Japanese automobile companies is often uncritically interpreted as a result of superior human resource management, but this affiliation may also be related to the fact that core companies and core workers alike benefit from lower wages in peripheral supplier firms.

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