CHAPTER 14

Organisational Performance and Manufacturing Practices

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Total quality management, just-in-time, total preventive management and supply-chain partnership are all seen as modern manufacturing practices. They are often subsumed under umbrella concepts, such as Womack, Jones & Roos's (1990) lean production, Dean & Snell's (1991) integrated manufacturing, and Schonberger's (1986) world class manufacturing. Total quality management (TQM) may itself be one such umbrella concept (Cooney & Sohal, this book). Within social theory they have been viewed as a vital part of the post-Fordist model, "Toyotaism" in some people's terms (Wood, 1989). The contrast is often drawn between this new approach to management and the excessively rigid Fordist system, which was based on Taylorist principles of job design, with a narrow division of labour, highly functional management and low role demands for the mass of workers. Womack *et al.* (1990) encouraged the differentiation of lean production from mass production, while TQM has been portrayed by some as a major cultural force—an enterprise lifestyle (McCloskey & Collett, 1993)—which represents a radical change in the way organisations operate.

Portrayed in such terms, lean production and TQM became in the late 1980s panaceas for management and the ills of Western economies: the low productivity, poor quality and industrial conflict. Their extension to all fields of industry and commerce was urged. Womack *et al.* (1990, p. 277), indeed, proclaimed that lean production would become "the standard global production system of the twenty-first century", seemingly taking it for granted that their exhortations would be heeded. Having conceived the management methods of lean production literally as a machine, they effectively turned it into a juggernaut that would eliminate in one fell swoop many, if not all, of the production, organisational and personnel problems associated with post-war Western economies.

Prescriptive packages of practices tend to be all-embracing concepts that offer a fresh way of thinking, as well as urgently needed practices. In the case of lean production, the emphasis is on viewing the organisation in the context of its suppliers and customers and in terms of a flow of activities pulled by the customer. The aim is to eliminate all elements of this system that add no value to the customer. Lean production and other such approaches were part of a movement to elevate operational management within the overall concerns of management (Abernathy, Clark & Kantrow, 1984). Prior to this, the over-riding emphasis of

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corporate strategy, in theory and practice, was on the development of products and markets, with some consideration given to technology. As an antidote to this, lean production and TQM have often been presented as if they could (and should) become the business strategy of the organisation.

Nonetheless, they are perhaps more limited than their architects imply. First, within them certain practices are given prominence, e.g. just-in-time (JIT) in lean production, decentralisation of quality control in TQM. Second, the practices themselves are likely to be orientated towards specific objectives, e.g. JIT to reducing costs and customer responsiveness. Third, they have evolved as reactions to past omissions in operational management theory and the problems that arose in its application. Problems of inventory management and integration were ill-considered within the Fordist and Taylorist theories of mass production. In practice, Fordist mass production was plagued by certain nagging and recurring problems: poor quality, bottlenecks, rigidities, difficulties of balancing the work of operators, and the unreliability of suppliers. Lean production was a novel way of addressing the loose ends of Fordism in theory (Walker, 1989, p. 65) and in practice (Wood, 1993). Similarly, TQM emerged to overcome the quality problems that the functional approach to quality control had either created or failed to address.

Finally, there is a tendency for the proponents of the packaged programmes of manufacturing practices to concentrate on the technology to the neglect of human and social issues. This means they under-consider two things: (a) the vital role of employee involvement in their programmes, and (b) the problems of implementation. What are sometimes called the "soft" or "people-orientated" practices, such as teamworking or continuous improvement methods, are integral to the programmes but often presented in a sanitised way, on a par with a measurement instrument, when in fact they are the conduits through which the techniques are applied. Moreover, the problems of implementation run deeper than getting people to administer the techniques competently. They involve overcoming the existing forms of commitment, control and conflict that the past system(s) of management, and particularly their functional roots, have created. In the quest to present manufacturing practices as the means of achieving leanness, total quality or world class status, authors skate over whether they can fully resolve the tensions within organisations, between groups, and between job demands and employee satisfaction (see Delbridge, Chapter 2, this volume).

The fundamental question then raised by the portrayal of manufacturing practices as the saviour of Western economies is: how are they faring? This involves at least three issues: (a) to what extent are they diffusing?; (b) to what extent do the practices associated with lean production, TQM and high involvement coexist, or is there a mirroring of the theorists' over-emphasis on techniques of operational management to the neglect of the organisational and personnel practices?; (c) is their use leading to the superior performance prophesied? No one study has thus far addressed all these questions together. Indeed, the number of studies that includes operational and human resource practices is very small. My purpose in this chapter is to overview these studies in order to take stock of what we have by way of answers to the three questions.

The literature discussed is from two areas: production management and human resource management. In the former, primacy is given to the operational practices, JIT and TQM, and the human and organisational elements are conceived as infrastructrual supports for the successful adoption of these, while in the latter, the emphasis is placed on employee involvement and then the issues are: (a) the extent to which the operational management models have spurred and shaped their development; and (b) whether "employee involvement

without TQM practices is less likely to affect performance positively and vice versa" (Lawler *et al.*, 1995, p. 144). If successful, the combined use of modern manufacturing and involvement methods should result in employees being flexible, expansive in their perceptions and willing to contribute proactively to innovation. Their main effect on performance is thus through work restructuring, innovation and learning, not through employee commitment.

THE DIFFUSION OF MANUFACTURING PRACTICES

Bolden *et al.* (1997, p. 1114), at the Institute of Work Psychology (IWP), Sheffield, developed a list of 70 modern manufacturing practices based on the literature and experts' views. They range from the very specific (e.g. computer-aided design) to the abstract (e.g. company vision and organisational culture). The studies thus far have, though, concentrated on those most connected with lean production, integrated manufacturing and TQM, such as JIT, decentralised quality control and computer-integrated manufacturing.

Following directly from Bolden *et al.*'s (1997) conceptual work, the IWP team (Waterson *et al.*, 1999) investigated the use of some of the key practices that they identified in this. The survey, conducted in 1996, was based on a sample of 564 UK manufacturing companies with more than 150 employees. It confirmed that most of the practices were "new", as most of them had been introduced recently. In over 75% of the companies that used business process re-engineering, TQM, team-based working, empowerment and a learning culture, the practice had been introduced in the 1990s, While in the case of all other practices—JIT production, integrated computer-based technology, supply-chain partnering, total productive maintenance, concurrent engineering, manufacturing cells—the figure was over 60%, with one exception, outsourcing, where only 39% of the users had introduced it in the 1990s.

In 2000, the IWP team conducted a follow-up study of 126 of those in the 1996 study. In this, only the seven most prevalent practices in 1996 were included—TQM, JIT production, integrated computer-based technology, supply-chain partnering and team-based working, empowerment and learning culture. The use of all seven had increased significantly but their relative use had not changed significantly. Learning culture and empowerment remained the least used[1]. The most significant increases were in the usage of integrated computer manufacturing and supply-chain partnerships. There was also no evidence that the practices inevitably wane over time.

A more limited study by Wood & Albanese (1995, p. 234) showed an increasing use of practices between 1986 and 1990 in a sample of 135 manufacturing plants in the UK. The percentage of plants where operators were responsible for their quality and inspection, a key TQM practice, had increased from 51% to 76% in that period, while those having flexible job descriptions had increased from 38% to 69%, working in teams from 41% to 62%, and participating in quality circles from 8% to 16%

For the USA we also have similar evidence. In Osterman's (1994) data set of 871 establishments with 50 or more employees in both manufacturing and services, there was information on the date of introduction for four key practices—teams, job rotation, cross-training and statistical process control. Analysis showed that their usage for the core occupational

[1] This is based on the author's own analysis of the 2000 data.

grouping in workplaces had increased considerably in the 10 years prior to the survey, which was conducted in 1992[2].

Lawler, Mohrman & Ledford (1998, p. 60), using samples ranging from 32% to 22% of the Fortune 1000 largest manufacturing and service companies, also reported a similar trend. The use of key modern manufacturing practices—self-inspection, statistical process control for front-line employees, JIT deliveries, cell-production, employee participation groups—increased both across the economy and within these firms in the 1990s. Quality circles, however, decreased slightly in this period.

THE COMBINED USAGE OF MANUFACTURING PRACTICES

If the operational and human resource practices form a system we would expect them to coexist and, perhaps more importantly, for this coexistence to reflect an underlying managerial orientation toward integrated manufacturing. Studies addressing this question are limited in number and scope, as they concentrate simply on the association between the usage of practices. Wood (1999) and his colleagues (de Menezes, Wood & Lasaosa, 2002) have, however, made the examination of whether any association between them reflects an underlying integrated approach to management a core concern. The research thus far has mainly concentrated on TQM, JIT and high-commitment practices, with some attention being given to computer-based manufacturing.

Osterman

Osterman (1994) attempted to gain a picture of the combined use of TQM and human resource practices by aggregating their usage. Four practices were measured: TQM, quality circles, teams and job rotation. Osterman examined all possible combinations of the four practices constituting his measure and found that 36% of the workplaces used none of these, while 14% used only teams and 7% used only job rotation. All the other subsets, including the use of all four practices, were each to be found in less than 5% of the establishments. From this, Osterman concluded that no single major dominant cluster of practices emerged from the data and, by implication, that the HR and TQM practices do not necessarily go together.

Lawler, Mohrman & Leford

Lawler, Mohrman & Ledford (1995) acquired information on both TQM and employee involvement practices in their 1993 company-level survey. TQM practices were grouped into two main categories: core- and production-oriented. Core practices included quality improvement teams, cross-functional planning and customer satisfaction monitoring; while production-orientated practices consisted of self-inspection, JIT deliveries and work or manufacturing cells. Information was collected for four types of employee involvement practices, grouped under the following headings: information-sharing, training and skills, reward systems, and power-sharing.

[2] This is based on the author's own analysis of Osterman's data.

Lawler *et al.* used simple pair-wise correlations to examine the relationship between the individual TQM measures and the four indices of employee involvement, as well as an overall index based on the average scores across the indices. The correlations on a high proportion of all pairs involving the information-sharing, skills, and power-sharing indices were all significantly above zero, but the rewards index was only (weakly) related to one of the TQM practices, self-inspection. The correlations on the three other indices ranged from 0.47 to 0.08. Lawler *et al.* (1995, p. 58), somewhat over-zealously, concluded that "most companies have both employee involvement and TQM initiatives" and that they "are most frequently coordinated or managed as one integrated program". The size of the correlations between the use of particular TQM practices and the employee involvement indices was not consistently high enough to suggest that the dominant pattern is a fully integrated TQM and employee involvement. Neither was the frequency of use of many of them: while most firms used at least some of the practices, the typical firm used most of the practices with only 1–20% of its employees. In the absence of multivariate analysis, it is not in fact possible to conclude that TQM and employee involvement practices tend to coexist or form a unified package. In a second survey in 1996, the correlations were again varied and not especially high (Lawler *et al.*, 1998, p. 68).

Patterson, West & Wall

For the UK, Patterson *et al.* (2002), in another study at the Institute of Work Psychology, went beyond the focus on TQM or JIT by including computer-based manufacturing—a form of advanced manufacturing technology (AMT)—in their study. Following Dean & Snell (1991), they took these to be the core of integrated manufacturing. They investigated these three practices in relation to two dimensions of empowerment, job enrichment and skill enhancement.

Patterson *et al.* collected their data in a sample of 80 manufacturing firms in the UK, drawn mainly from metal goods, mechanical engineering and the plastics and rubber sectors. They were all single-site companies selected on this basis in order to get performance data from publicly available accounts which would tally with the best level for collecting data on practices, namely the workplace. Patterson *et al.* did not simply rely on the responses to structured questions of the managers or employees in the firms. They first collected data from interviews conducted on site that typically involved the chief executive, the production director, the finance director and the personnel director. Different respondents were used for different practices. Patterson and his colleagues then supplemented this with information from relevant company documents and their own observations of work practices. Given this "wide array of information" (Patterson *et al.*, 2002, p. 14), the researchers scored the practices on the basis of their own ratings, using the information from all three sources.

None of the five measures—AMT, JIT, TQM, job enrichment and skill enhancement—were heavily correlated. Patterson *et al.* (2002, p. 20) concluded that this does not justify treating any of them as "composite constructs" i.e. as part and parcel of the same phenomenon. Nonetheless, subsequent multiple regression analysis of the association between the three manufacturing techniques and the two human resource practices revealed that TQM and JIT were significantly related to both job enrichment and skill enhancement, while AMT was related to skill enhancement but not enrichment. This adds support, within the limits of cross-sectional data, for the idea that production concepts drive the human resource practices, as well as that they enhance jobs, rather than de-skill them.

Sakakibara *et al.*

From the production management literature, Sakakibara *et al.* (1997) investigated in the USA a set of practices that they viewed as either constituting JIT manufacturing or its infrastructure. For JIT, six practices were identified: set-up time reduction, scheduling flexibility, maintenance, equipment layout, *kanban*, and JIT supplier relationships; while five types of infrastructure practices were identified: product design for manufacturability, workforce practices geared towards flexibility, organisation characteristics relating to the reallocation of decision rights, quality management and manufacturing strategy.

Forty-one plants were sampled (representing a 60% response rate) and within each of them 21 questionnaires were completed by a variety of managers and workers in three industries (transport components, electronics and machinery). The average of the scores for each sub-practice was taken as the plant usage of the practice. To create the overall superscales, the average score over the sub-practices for each type of practice was calculated. So the JIT score was based on the above six practices. The reliability of each scale was over the conventional 0.60 level, which suggests that the various practices tend to coexist. In investigating their coexistence, Sakakibara *et al.* (1997) adopted a correlational analysis similar to that of Lawler *et al.* (1995). The JIT scale was significantly correlated with the infrastructure scales—product design, workforce management, organisational characteristics, quality management and manufacturing strategy. They were all at the 0.45–0.51 level, with the exception of workforce management, which was 0.61. The weakest correlations involved product design and quality management. The correlations between the infrastructure scales were however, generally higher, these ranging from 0.52 (product design and workforce management) to 0.85 (product design and manufacturing strategy). Sakakibara *et al.* (1997) concluded that this "implies that a plant that shows strengths in quality management and manufacturing strategy is very likely to have good practices in other areas".

Wood

In making the examination of the relationship between practices a core concern, Wood went beyond correlational analysis since, for him, this alone is not the defining criterion of a system. Rather, coexistence implies a need to investigate further and assess the nature of any underlying orientation that explains the associations between the practices. Addressing this amounts to an investigation of whether umbrella concepts like lean production and integrated manufacturing represent identifiable phenomenon. In the absence of confirmation of this, they remain simply part of the discourse of management thought, not of reality, and practices may simply be being used in an *ad hoc* way. The central research question Wood addresses is, then, whether the relations amongst a set of operational and human resource practices reflect one of three possibilities:

1. Differing degrees of usage of an integrated management system combining both types of practices.
2. The operational and human resource dimensions are separate and thus, for example, TQM or JIT and high-involvement management are pursued as distinct approaches.
3. Practices are adopted in an *ad hoc* way rather than as part of a systematic approach.

Having earlier concentrated on human resource practices (Wood & Albanese, 1995; Wood, 1996; Wood & de Menezes, 1998), Wood (1999) examined the link between these and manufacturing practices using Osterman's data. It appeared to Wood that, on the basis that there was a wide diversity of combinations of practices in use in his sample of firms, Osterman's conclusion that there was no dominant system was too hasty. This diversity does not necessarily mean that there was no underlying pattern to the data.

Wood examined the pattern of association that existed between the set of total quality and human resource practices in Osterman's data set to see if it reflected an integrated quality and human resource approach, using latent variable modelling, as developed by Bartholomew (1987) and others. This assesses whether any association between items (i.e. the use of practices in a workplace) can be explained by a common factor or factors. Factor analysis is the most well-known latent variable model, but in this case the practices were binary and thus Wood attempted to fit latent trait models, in which the latent variable is, as in factor analysis, continuous, but the manifest variables are binary or categorical. Wood used more than the four practices that Osterman used as, in addition to quality circles, teamworking and job rotation, there was data on cross-training, human relations skills as a selection criterion, internal recruitment, employment security policy and statistical process control. He also excluded TQM, as the question treated it as a generic concept, not a practice.

Initially, a two-factor model fitted the data best. One factor loaded on quality circles, statistical process control and teamworking, all practices associated with TQM, and the other loaded on the two practices associated with labour flexibility, job rotation and cross-training, and to a lesser extent teamworking. This suggested that the first measure was a quality dimension and the second a human resource one, and that the use of quality and human resource practices reflected distinct approaches. This was supported by the fact that the first was correlated with the reported use of TQM but the second was not.

An examination of the distribution of the workplaces in the sample on the two scales revealed, however, that the workplaces divided into clearly recognisable groupings, and that the two groups were separated by whether or not they had quality circles. Given that quality circles were an important source of differentiation between establishments, a further latent trait analysis was conducted without this item being included. This time a one-factor model fitted the data well and the average score on this one-factor latent scale was significantly higher for those establishments claiming to use TQM than it was for those not pursuing it. The results of this second stage of analysis suggested that the two-factor model in the first stage was a false resolution and was misleading. Wood thus concluded that the latent variable is measuring an integrated high-involvement quality management.

Wood's re-analysis of Osterman's data revealed a picture that is more complicated than the three possibilities that he conceived at the outset. There was no fragmentation between quality and human resource practices. But quality circles have been shown to be distinct from the other practices, which Wood suggested is likely to be a reflection of the ambiguity towards them within management circles. Overall, the results suggest that something akin to an integrated total quality high involvement is an identifiable phenomenon.

De Menezes, Wood & Lasaosa

Wood's work has been extended, with his colleagues de Menezes and Lasaosa (de Menezes *et al*., 2002), through an analysis of the UK Workplace Employee Relations Survey of 1998

(WERS98). The focus was on high-involvement management in the context of TQM. First, their definition of high involvement as a task-centred approach to participation reflected the lean production/TQM model. It involved:

1. The combined use of managerial practices for working flexibly and producing innovation.
2. An orientation on the part of employers to develop and harness the human capital of the organisation.

At its core were task-level practices, such as quality circles, job flexibility and team working. But it involved two types of support practices:

1. Individual supports, through which individuals are given training and information to engage successfully in such practices.
2. Organisational-level supports—practices such as minimal status differences and job security, which are directed at the recruitment and retention of people who are able to work in a high-involvement manner.

Second, there should be a relationship between high-involvement management (HIM) and modern operational management methods, and particularly TQM. Consequently, de Menezes *et al.* (2002) examined the pattern of relationships amongst core HIM practices, the two types of supports and TQM techniques.

The WERS98, which they used, consists of a sample of 2191 workplaces with 10 or more employees across the whole economy, representing a response rate of 80% of the targeted sample. From WERS98 de Menezes *et al*. developed four measures of the task HIM practices—team working, functional flexibility, quality circles and suggestion schemes; five individual supports—induction procedures, team briefing, information disclosure, appraisal, and training in human relations; and six organisational supports—survey feedback method, commitment as a major selection criterion, internal recruitment, single status between managers and non-managers, job security guarantees, and variable pay. They measured TQM by seven practices: self-inspection; quality monitored by records of faults and complaints; quality monitored through customer surveys; records on quality of product or service that are not confidential to management, quality targets set; training on quality control; and training in problem solving. In addition, they used a measure of the use of JIT procedures.

A number of the variables were dichotomous by nature (e.g. single status) or recorded as binary in WERS98 data. The others were based on questions that asked for the percentage of employees covered by the practice, and de Menezes *et al.* (2002) found that the distributions of these practices were either multi-modal or skewed, so the variables were redefined as binary. Again adopting latent variable modelling, de Menezes *et al.* fitted latent trait and latent class models to the data. Motivation as a selection criterion and JIT were not related to any great extent to the other practices and were excluded from their main analysis. Initial stages of a step-wise procedure produced models that did not fit well and the source of the problems was diagnosed to be all the organisational supports. These practices were consequently not crucial for an integrated high-involvement quality system that is grounded on an underlying managerial orientation, and therefore were excluded from the final analysis. Latent class models, which included different combinations of the high-involvement and total quality practices, fitted the data better than any latent trait model. This means that the orientation underlying their use was best measured in terms of three grades, i.e. on a discontinuous, not continuous, scale. The population was divided into three homogeneous groups, which were identified as low, medium and high, i.e. on a discontinuous, not continuous, scale.

However, four such models were identified which were equally valid statistically. One model simply contained all the high-involvement practices. The three others incorporated elements of TQM and thus supported a broader and integrated concept of high-involvement management. These varied in emphasis; one was very biased towards TQM, another gave more weight to information dissemination, and the third favoured a more integrated (involvement–quality) approach. Within these models, the common core practices were self-inspection and customer surveys, and their likelihood of usage clearly increased from the low through the medium to the high class. All four classifications correlated with a measure of the degree to which employee involvement was embedded in an organisation, based on the manager's self-report.

The existence of four observationally equivalent models is not a problem. But there is uncertainty about what underlies the findings. On the one hand, the diversity may be indicative of different managerial orientations, i.e. just as in academia, there may be no consistent perspective on the high involvement–TQM link, there are differences between managements across the economy. Some managements may see them as distinct, while those that see a connection may view this link in different ways. On the other hand, the diversity of models may simply reflect the sparseness of the data, for even with seemingly a large data set like WERS98 there was a large number of patterns of responses that are observed only once. While de Menezes *et al.* (2002) could not say which of the two possibilities explained the variety of models, they did suggest that there were signs that, with a larger data set, the integrated high-involvement–quality management (HIQM) model might very well outperform others. Their study certainly implies that high involvement management (HIM) and TQM are overlapping concepts. So, despite the indeterminacy in the results, this study points to the value of the TQM–HIM model and suggests that:

1. The task practices are being used in conjunction with quality practices and may well be part of TQM.
2. The core of high involvement in the UK are the task practices associated with TQM carrying with it the implication of an underlying management orientation centred on continuous improvement.

The evidence thus far on the nature of the relationships amongst modern manufacturing practices is limited. Correlations alone may be misleading. However, there is sufficient in the results, particularly in the results of the latent variable studies, to suggest that the usage of practices is not *ad hoc*. The extent to which they are combined under one truly integrating concept is unclear, but it would appear that if any one such concept underlies management's use of these practices, it extends across the operational and human resource boundaries.

MANUFACTURING PRACTICES AND PERFORMANCE

Most of the research linking manufacturing practices to performance has concentrated on assessing which, if any, of TQM, JIT, HIM or other human resource practices have the most effect. Each of these has typically been measured by a number of sub-practices. Researchers have also attempted to see whether any performance effects depend on other practices being used, or at least are enhanced when they are present, i.e. to test for any synergistic relations amongst practices. If this is the case, it is the interaction effect between practices, and not the practices themselves, that should explain most of the variation in performance. In this

way, a system could be identified as the set of practices that has strong performance effects. Since any reactive effect between the practices will occur regardless of whether they tend in general to coexist, it is an alternative concept to that underlying the latent variable analysis of Wood and his colleagues. Their notion, that integrated management is ultimately an underlying orientation, implies that the practices form a coherent system that reflects management's use of them as a package, albeit to varying degrees, and does not imply synergistic effects between practices but rather, as we have seen, that this coexistence will be explained by a common factor. Moreover, it may well be that although the practices form an integrated set, their collective use may not result in superior performance to other packages that reflect other integrated approaches. It is thus necessary to differentiation between synergistic and orientation-type arguments. We shall review the literature, first presenting the research which has attempted to examine synergy, ordering this according to the extent to which it has found any, before concluding with the one study based on orientations.

Patterson, West & Wall

Patterson, West & Wall (2002), uniquely, used official accounting data to measure performance. Two indices were used, labour productivity and profit. Labour productivity was measured as the logarithm of the financial value of net sales per employee, divided by labour productivity for the sector, to make it relative to the sector. Profit (before tax) was measured as the financial value of sales less costs per employee. Both productivity and profit were measured for a period of 3 financial years prior to the collection on the data on practices and for the financial year in the year following this. Patterson *et al.* (2002) were able to assess the association between five practices—TQM, JIT, AMT, job enrichment and skill enhancement—and the level and rate of change of both productivity and profits.

Using multiple regression analysis, the study showed that of the three operational practices, only AMT was significantly related to productivity. It was not, however, related to profits, the implication being that the effect of AMT on productivity is countered by investment costs. But both job enrichment and skill enhancement were related to both. Close examination of this revealed that the effect on profits of these two human resource practices was accounted for by its effects on productivity. Similar results were found when the change in productivity and profit was considered. Analysis of the interaction between the practices revealed no significant or meaningful results. There was thus no evidence of any synergistic relationship between integrated manufacturing and empowerment practices.

Lawler, Mohrman & Ledford

Lawler *et al.* (1995, pp. 87–92) examined the issue of synergy at the company level, using their data from the Fortune 1000 largest manufacturing and service companies. They analysed the effects of employee involvement (EI) and TQM on measures of economic and financial performance. The measures were total productivity, sales per employee, return on sales, return on assets, return on investment, and total return to investors. They conducted multiple regression analysis of the effects of EI and TQM, controlling for industrial sector and capital. EI and TQM variables were most strongly related to return of equity and return on assets, while all of the other outcome measures were significantly, but weakly, related to their

usage, with the exception of the total return on investment. The percentage of corporate performance variance that was accounted for by EI and TQM practices was, however, relatively small; nonetheless, because of the wide range of performance, small movements in these practices could have translated into a relatively large effect on performance. A one standard deviation increase in EI and TQM practices would, Lawler *et al.* (1995) estimated, mean an additional 30% of employees within a company being covered by them, and this would have had quite big effects on five of the six performance indicators.

For the 1996 data, Lawler *et al.* (1998, pp. 142–153) did not report the results of a regression analysis on the effects of the combined use of EI and TQM on financial performance, as they did in 1993. It was, however, shown to be the case that the high users of both EI and TQM did in fact perform better on return on sales, return on assets, return on investment, and return on equity. A regression analysis of EI usage on its own showed that it was related to sales per employee and return on assets, as it was in 1993. Additionally, it was related to return on investment. However, it was not, as was the case in 1993, related to return on sales and return on equity. TQM usage, when assesssed in isolation of EI, was related to return on sales, return on assets and return on equity, which was not the case for 1993. The strength of the overall conclusion of the studies, that financial performance was affected by the use of EI and TQM, was enhanced by time-lagged analysis which showed that the use of practices in 1993 was related to financial performance in 1996, although no information was given to show that financial performance in 1993 was unrelated to the use of practices in 1996. So overall, Lawler's research, within the limits of its methodology, offers some support for the argument that HIM and TQM both constitute what Lawler *et al.* want to see as the high-performance system.

MacDuffie

MacDuffie (1995) conducted a single-industry study based on the 62 final assembly plants in the major car-producing countries, using data from the MIT Future of the Auto Industry project, the birthplace of the lean production concept. His work was a major attempt within the programme to investigate the human resource or high-involvement (Pil & MacDuffie, 1996) side of lean production. He measured the extent to which the production regime was lean, or bufferless, by the percentage of total assembly area space dedicated to final assembly repair, the average number of vehicles in the work-in-process buffer between the paint and assembly areas (as a percentage of one shift's production), and the average level of inventory stocks for a sample of eight key parts (weighted by the cost of each part). MacDuffie differentiated two types of HR practices, which he labelled "innovative work system practices" and "innovative HRM practices/policies". He measured the former by practices that are often associated with TQM: the existence of work teams, problem-solving groups, job rotation, decentralisation of quality-related tasks and an effective system for employee suggestions. The HRM policies included such high-involvement practices as selection criteria geared towards openness to learning, interpersonal and teamworking skills, a contingent pay system, and minimum status differentials.

Through cluster analysis, he identified three discrete types of plants. At the extremes were lean plants or flexible production systems with few buffers and the characteristics of both innovative work systems and human resource systems, and traditional buffered plants, which made little use of innovative work or high-involvement practices, hired on the basis of a

simple match to the job requirements and trained very little. Between these was an intermediate group, which used buffers and innovative human resource practices to an extent that was half-way between the two other systems, but its usage of innovative work systems was at a similar low level to the traditional "mass" plant.

MacDuffie assessed the relative performance of plants within the three clusters on productivity, measured by the number of hours taken to build a vehicle (adjusted to allow for factors such as size of vehicle, number of welds and absenteeism) and quality, measured by consumer reports of defects per vehicles, as collected by a market-research company. Lean production plants were superior on both performance criteria, while the intermediate plants also performed better than the traditional ones on both these measures, although their quality levels were far closer to the traditional than they were to the lean plants. All the three elements of the lean production system, the non-use of buffers, the work system and human resource management, were related to productivity, and moreover, there was a strong interactive effect between them. The results for quality were less strong. For while work system and human resource practices were related to quality, the low use of buffers was not, neither was there an interaction effect between work system and human resource practices. Nevertheless, there was an interaction effect between having low buffers and the work system practices, suggesting that JIT was only working when work organisation was based on TQM principles. The interaction between buffers and human resource practices was significant but negative, not as expected, the implication being that lean production was working best when not allied with high-involvement practices.

Taking the work system practices as indicative of TQM, the evidence on both performance criteria could be taken as support for the argument that there is a synergistic relationship between TQM and JIT. The added effect of human resource practices on productivity may add credence to MacDuffie's claim that the three practices should be treated as part of the same phenomenon. The evidence of the effects on quality, however, was not so clear-cut as it implies that human resource practices have the opposite effect to those expected or even intended by those introducing them. The factor analysis of the practices that MacDuffie reported also implies these can not be seen as an integrated set of practices on the basis of their joint usage. The limited number of plants with the bufferless system and high-commitment practices in the sample may have affected the results.

Flynn, Sakakibara & Schroder

Flynn, Sakakibara & Schroder (1995) evaluated the effects of JIT and TQM on what they called JIT performance and TQM performance. In their study, JIT practices were of four types: *kanban*; lot size reduction practices; JIT scheduling; and set-up time reduction practices. TQM practices are classified into three types: statistical process control (SPC); product design for quality; and customer focus practices. Infrastructure practices were practices which have typically been seen as "supporting both JIT and TQM" (Flynn *et al.*, 1995, p. 328). They pertained to five domains of manufacturing: information feedback, plant maintenance, management support, supplier relationships, and workforce management.

Flynn *et al.* (1995) started from the premise that TQM practices should be the prime determinant of TQM performance and JIT on JIT performance, but they also argued that TQM will affect JIT performance and JIT, TQM performance. For example, TQM can reduce manufacturing process variance, which will reduce the need for inventory and shorten cycle times, and these are the key measure of JIT performance. Similarly, JIT practices may

be used to reduce lot sizes and this may impact on quality performance, since the potential rework and scrap resulting from process failure will affect batches of smaller sizes.

Flynn *et al.* (1995) tested two sets of related hypotheses, one for JIT performance and one for TQM performance. They ordered the sets hierarchically. Since common infrastructure practices lay the foundation for the use of the unique practices, they formed the first tier of both hierarchies: common infrastructure practices are positively related to TQM or JIT performance. The second rung was the practice that corresponds to the performance outcome, thus TQM for the TQM performance equation and JIT for the JIT performance one. Finally, the last step was the inclusion of the less proximal practice: JIT positively affects TQM performance and TQM is positively related to JIT performance.

Flynn *et al.* (1995) tested these hypotheses using data from a stratified sample of 75 manufacturing plants in the US electronics, transportation components and machinery industries. They acquired information on the practices from a range of selected informers in the plants—operatives and managers—using questionnaires. Information was acquired on a number of practices falling under the 12 dimensions that Flynn *et al.* (1995) identified, e.g. three in the case of customer focus, statistical process control and most JIT methods, and nine for workforce management. They omitted two infrastructure sets of practices (information feedback and work management) and one JIT practice (set-up time reduction practices) on the grounds that they were relatively highly correlated with other independent variables, which might not have been necessary on statistical grounds as the correlations were not above 0.60.

Reflecting the way that they had organised the hypotheses, Flynn *et al.* (1995) conducted hierarchical regression analysis on the data. The first stage of the analysis of JIT performance revealed that a significant part of the variance could be explained by the infrastructure practices, the second stage that JIT practices added significantly to this, but the third stage revealed that the TQM measures had no significant effect. The final equation showed that management support had by far the greatest effect, while lot size was weakly related. A third factor, supportive plant environment, was also significantly related to JIT performance but the relationship was negative, not positive as expected.

Tests for interaction effects between practices suggested that having a supportive plant environment did, however, enhance the effects of (a) statistical process control, (b) JIT scheduling, and (c) lot size reduction practices. In addition, having supportive management and a customer focus both also strengthened the effect of JIT scheduling. The interaction between supportive management and *kanban* was negative, suggesting that they were operating as substitutes.

The analysis of TQM performance revealed even stronger effects from infrastructure practices ($R^2 = 0.51$ for stage one). The additional R^2 for the next two stages was not, however, significant. In the final model only the infrastructure practices were significant, management support and supplier relationship both were more strongly related to TQM performance than the third practice, plant environment, which was positively, albeit weakly, related to it. The sign of JIT scheduling was in fact negatively related to quality. Interaction analysis revealed that supportive management enhanced the effect of JIT scheduling and that supplier relations, likewise, intensified the effect of product design and JIT scheduling.

The few significant interaction effects between the supports and TQM (and JIT) practices did not suggest that they have joint effects. The research in fact showed that infrastructural supports have important effects on performance in their own right. Managerial support was especially significant. JIT scheduling was especially important for both JIT and TQM performance but its effects were not realisable without the infrastructural supports. Overall,

TQM practices appear to have little effect on the basis of this study. But statistical process control will, in the context of a supportive plant environment, affect JIT performance, while product design, when coupled with supplier relations, has an effect on TQM.

Nonetheless, the conclusion that Flynn *et al.* (1995, p. 1354) draw from their study is "that there is a relationship between TQM and JIT practices and performance" and "that although TQM and JIT function effectively in isolation, their combination yields synergies that lead to further improvements". Given that no unconditional effects of either JIT or TQM were found, nor were any significant synergies between any two types of JIT or TQM practices, this is clearly wrong. Moreover, it appears that the infrastructural practices had an independent effect in isolation of the existence of JIT or TQM practices[3]. Since the managerial support measures were biased towards quality rather than JIT, it would appear from this study that it is having a philosophy geared to quality and not the practices *per se* which is crucial for quality and JIT.

Cua, McKone & Schroeder

Cua, McKone & Schroeder (2001) investigated the effects of three operational practices, TQM, JIT and total productive maintenance (TPM). In a similar vein to Flynn *et al.* (1995), they distinguished the key practices that are uniquely associated with each of these from those that are common to them, and which in their terms are "supporting" mechanisms (Cua *et al.* 2001, p. 680) that strengthen the impact of operational practices on performance.

In their study, unique TQM practices were cross-functional product design, process management, supplier quality management, and customer involvement; unique JIT practices were set-up time reduction, pull system production, JIT delivery by suppliers, equipment layout, and daily schedule adherence; and TPM practices were autonomous and planned maintenance, technology emphasis and proprietary equipment development. The common practices were, in Cua *et al.*'s (2001, p. 679) terms, human- and strategic-orientated practices, and were: committed leadership, strategic planning, cross-functional training, employee involvement and information and feedback. Data was gathered from a survey of 163 manufacturing plants in five countries (USA, Japan, Italy, Germany and the UK), which were randomly selected in each country from three industries, electronic, machinery and transportation parts suppliers. In each plant, 26 respondents completed a questionnaire (12 were direct labourers and 14 were managers) and multiple observations of a practice were averaged to form a score for each practice. The data on performance was collected from one source, the plant manager. He/she was asked to rate the plant's performance relative to its competitors on four dimensions: cost efficiency, quality of product conformance, on-time delivery and volume flexibility. In addition, a composite performance measure based on a

[3] Flynn *et al.* (1995, p. 1351) appear to have concluded that there is an effect of TQM on the grounds that the results reflect the ordering that the variables were inserted in the hierarchical regression analysis. So, while the inclusion of TQM practices in the TQM performance equation, for example, added little to the starting model that just included infrastructure supports, had these formed the first stage they may well have been significant. But this is insufficient to justify a TQM effect. While the R^2 associated with TQM practices may be greater if they were included first, any significant regression coefficients for TQM at this stage would not survive the inclusion of the other variables. Flynn *et al.* (1995, p. 1350) also argued that the low addition to the R^2 following the inclusion of the TQM set may have reflected the fact that there is an overlap between the unique TQM variables and the common infrastructure. The precise meaning of this in substantive terms was, however, unclear, especially as it was being gauged from an analysis of the practices' effects.

weighted sum of the four performance measures is developed, where the weights reflect the strategic importance that the plant places on the performance dimension.

Cua *et al.* (2001) first divided the plants into high and low performance and then conducted discriminant analysis to assess which practices discriminated between the two groups. First, they created four composite measures of all the four types of practices, TQM, JIT, TPM and common or support practices, and then investigated their relative importance in discriminating between the high and low performers. The discriminant loadings for all four composite measures were all high, 0.53–0.85, over all five performance indicators, and the overall model fit was good for all equations. JIT was most significant for cost efficiency, and TQM was more important for quality and volume flexibility and even for on-time delivery. TPM was the least significant for all measures, except for the weighted measure, where JIT was slightly less significant than it, the implication being that cost efficiency was weighted highly in the measure. The discriminant loadings for the common practices were either the top or very close to the top rated practices for all the performance measures.

Second, the authors conducted a similar analysis using the individual practices that made up the TQM, JIT, TPM and support practices. The results confirmed that at least one practice from each of these "sets" had an impact on all the performance measures. For TQM, all four were important for on-time delivery, all but customer involvement was important for quality and the overall performance measure, customer involvement was the only practice significant for volume flexibility, while it and supplier management were important for cost efficiency. For JIT practices, JIT delivery from suppliers was the only important item for all the performance measures, but set-up time reduction and pull production were also significant in the case of cost efficiency. Technology emphasis was the only TPM practice which was important for all performance measures, while planned maintenance was significant for cost efficiency and on-time delivery. In the case of the supports, committed leadership was a highly significant practice in all performance models. In the case of volume flexibility, it was the only such practice of any significance. For on-time delivery all the other supports were significant; for cost efficiency all but strategic planning were; for quality, only strategic planning and employer involvement were significant common practices. Finally, for weighted performance, only strategic planning was significant.

Overall the study suggests that high performance is dependent on the use of practices across the range of JIT, TQM and TPM, as well as social and strategic mechanisms. The authors concluded that these practices are mutually supporting. But this is straying too far from their analysis, since their methodology did not allow them to test for interaction effects between the common practices and hence to see whether the common practices were complementing the operational practices. In fact, the common practices appear to be playing a main role. Moreover, their second analysis implied that the main effects on performance were from the use of specific practices within each program, not all elements.

Wood, de Menezes & Lasaosa

Wood and his colleagues (de Menezes *et al.*, 2002) investigated whether the three different classes identified in their latent class model using WERS98 data are associated with different levels of performance. They considered three performance indicators: financial performance, labour productivity, and change in labour productivity. De Menezes *et al.* (2002) ran regression models in which there were two dummy variables indicating membership

of particular latent classes, the minimal and partial high-involvement quality management, or high-involvement management (depending on the model). In each regression model de Menezes *et al.* (2002) controlled for all other types of practice that were not included in the specific latent class model being tested, e.g. in the model based on high-involvement practices only, all the organisational supports and a measure total quality management were included. Other control variables such as the size of the establishment were also included.

Membership of the high (third) class resulted in a significant increase in the change in labour productivity in the case of all four models. There were no significant effects on labour productivity. The results are consistent with the TQM/lean production theory, since it is centred on the importance of continuous improvement and thus the performance variable that is most significant to it is the rate of productivity change. This is itself not strongly linked to the other outcomes.

Finally, de Menezes *et al.* (2002) tested a key element of the theory of lean production, namely that it will reverse the tendency for there to be a trade-off between productivity and quality, that chasing high quality will result in low productivity (see Womack *et al.*, 1990). Analysis of whether high-involvement–quality management produced this virtuous combination of high productivity and quality revealed that it did, as it had the greatest effect on the relationship between the level of both. The effect was more pronounced for the integrated model than for high involvement management alone (the model that excluded quality practices).

DISCUSSION AND CONCLUSIONS

There is little doubt that the studies reviewed here are addressing important issues for our understanding of the new workplace. But when taken together, they do not offer any conclusive evidence of the diffusion, nature and effects of modern manufacturing practices. The limited studies of the changing use present a consistent picture of increased use over the past decade, and they suggest that this is not largely, if at all, reflecting faddism. Whether it is sufficient to represent the institutionalisation of lean production, TQM and high-involvement management implied by Womack *et al.*'s (1990) forecast is impossible to tell on the basis of the studies to date.

The evidence on the integrated use of the practices that we have reviewed is uneven. It is first uneven in quality, reflecting different methods of analysis; and second, in results, as some of the correlational analysis points to a limited coexistence between practices, while some of it implies a stronger collective use. The most systematic studies of the inter-relationship between practices by Wood and his colleagues have yielded promising results. In the case of the US (Osterman) data, Wood's analysis suggests that TQM (albeit with a limited number of measures) and HR practices may reflect some underlying integrated orientation on the part of management. In the UK (WERS98) case, the results are less clear-cut but certainly suggest that TQM and HIM are not unrelated phenomena and may well be (or even more than likely are) inseparable. This study suggests though that JIT may not be so integrated across the whole economy or even within manufacturing.

The findings on the performance effects are even more mixed. First, we have the Patterson *et al.* (2002) study, showing that it is the high-involvement (empowerment) elements of integrated manufacturing that are affecting labour productivity. Second, the evidence of

the Lawler *et al.* (1995, 1998) and MacDuffie (1995) studies imply—more strongly in the case of the latter—that the various types of practices have positive synergistic effects on performance. Third, we have the two studies by Cua *et al.* (2001) and Flynn *et al.* (1995), which conclude that similar synergistic effects have been found, when in fact either their statistical model does not test for this or the results do not support this conclusion. At best, Cua *et al.* show that that all three of TQM, JIT and HRM practices have effects. In the case of Flynn *et al.* (1995), consistent with Patterson *et al.*, it is the human resource elements that are important, and seemingly the managerial philosophy, not the use of specific practices, that has the most effect. Finally, de Menezes *et al.* (2002), in suggesting that the combined use of TQM and HIM may well reflect an underlying "holistic" orientation on the part of management, also put emphasis on management's approach rather than the practices *per se*, these being reflections of this.

Aside from the different results, the studies vary on a range of dimensions. First, they differ according to which practices they included. Second, they differ in the way that the practices were measured, some being measured continuously, others dichotomously. Third, some have relied on a single respondent for the measures of practices, others have used multiple respondents. Fourth, studies differ according to whether or not they attempted to assess the relationship between the practices before they measured their performance effects. Fifth, the unit of analysis differs between studies, and in particular whether they were conducted at the company or workplace/establishment level. Finally, the type of performance measures used in the studies varies, with some concentrating on manufacturing measures, others productivity or financial performance data. There is also a difference between the types of measurement of these indices, as most studies relied on the assessment of relative performance by a representative of the organisation, while only Patterson *et al.* (2002) used published company data.

Since the studies vary so markedly between each other, it is not possible to do any systematic comparison of them. Nonetheless, it is clear, even without this, that the marked differences between the results of the studies does not reflect in any systematic way the underlying concepts or designs of the studies.

A number of lessons can be drawn from this review. First, the minimum that we can take from it is that the study of operational and human resource practices are best not separated. Second, if we are to progress this area of study, it seems that we need a greater consistency of concepts and research design. At the same time we need to design studies which allow us clearly to test between alternative possible ways in which the practices may be used and having an effect. The two-stage strategy followed in some studies, and most strongly by de Menezes *et al*. (2002), seems vital. We need to: (a) investigate the association between practices to assess whether they are in fact used in concert and their use is indicative of an underlying management orientation, and if so what is the nature of this and, if their use is found to be systematic; then (b) measure whether the underlying orientation(s) can be correlated with performance, to see whether it is linked. Testing for synergy between practices is a separate activity. It clearly makes less sense if the practices form part of the same phenomenon.

Third, there are a number of limitations in all the studies, which will need to be addressed as research progresses. In many ways these mirror the limitations of the HRM–performance studies that Wood & Wall (2002, pp. 263–270) highlight. The main methodological one is that they are cross-sectional, although in the case of Patterson *et al.* (2002) they do link

practices to future performance. All but Patterson *et al.* (2002) are based on performance data that relied on the judgements of managers, and in some cases of a single manager, and the samples have been small and in many cases not representative. Only the WERS98 study used weights to correct any bias. Yet, the uncertainty in the results of the WERS98 study provide a salutary lesson in relying on small samples. Even with what would seemingly appear to be a large sample, we are not able to decide conclusively in favour of the integrated high-involvement quality model.

Conceptual limitations in the studies include a lack of attention to: (a) the mechanisms that link the practices to performance; (b) the effectiveness or depth of the use of the practices; and (c) the contingent nature of any use on performance effects. Attending to these issues will inevitably take us to the nuances underlying the theoretical discussions surrounding manufacturing methods. Four seem especially important.

First is the possible existence of different managerial perspectives on the relationship between the various types of practices. Even if it is subsequently discovered that, for the UK, the integrated high-involvement–quality model does reflect the UK situation best, this still leaves open two possibilities: (a) that managers differ in their view of its links to JIT and other practices not included in the study, and (b) there are different perspectives between countries. Second, there is the possibility of different types of lean production, TQM or high-involvement systems, in theory and practice, e.g. Sitken, Sutcliffe & Schroeder (1994) distinguish between TQM systems that are focused on controlling processes and add little involvement and those orientated towards organisational learning. Or there is the distinction between team-based systems which rely on heavy supervision and those based on self-managed teams (Appelbaum & Batt, 1994; Wood, 1990, p. 181). Third, there is also the question of the link between manufacturing practices and job enrichment, so central to this book. The research (Dean & Snell, 1991; Wood, 1993) specifically on this supports an additional conclusion of de Menezes *et al.*'s (2002) study, that core high involvement practices are being used alongside non-enriched jobs and that re-design of the basic tasks of a job does not seem to be central to integrated manufacturing. It also found that there were no extra performance gains from enriching the jobs when using high-involvement quality management. This analysis is tentative and needs much more research and conceptual thought. Finally, while incorporating the high-involvement practices in the analysis of operational techniques goes some way to addressing the human resource issues associated with their implementation, the focus and the methodology adopted in the studies may need to be extended if all the issues of conflict within organisations are to be addressed.

The burden of this review is that the limitations of the studies reviewed reflect, as much as anything, the fact that the debate is still in its infancy. So, while the methodological problems point to the need for a "big science" model for future research in this area, the conceptual limitations imply "little science" will also play a decisive role.

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