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Operations management – from Taylor to Toyota – and Beyond?

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SUMMARY **This paper sets out to review past and current research in operations management, and to explore current and future issues facing the area. It reviews the history of the area, and the patterns of research content and type. It reviews the evolution of lean production connecting the work of Taylor to its development at Toyota, and uses this to propose three key elements of operations management in the 1990s, namely, the core, interfaces and convergence. Current issues relating to research in operations management are explored and it is argued that there is a need for aggressive research agendas. Finally, possible future agendas for the area are explored.**

1. Operations Management – An Historical Perspective

Operations management as we know it today probably has its roots in two areas. The first is the work of people such as Taylor and the Gilbreths. The second is in the development of industrial engineering. Associated with this is the perennial concern with the development and adoption of process technology. Man has been making things throughout history, and concern with improving processes and their management has been reflected in writing from Agricola to Adam Smith. Following the development of industrial engineering and the refining of principles of mass production, increasing attention was paid to the role of production managers and the tasks and challenges facing them. In the 1940s two parallel developments brought a strong quantitative background to the area. The first was the development of the discipline of operations research which spread from its initial application in the military to a widespread application in business. Second was the work started by Shewhart in the application of statistical principles to process control and quality management. The development of computing in the 60s and 70s led to increasing focus of production planning and control and on computer integration of manufacturing. Finally, studies by professors at Harvard of the performance and policies of manufacturing companies in particular industries led to the belief that there was a strong link between choices in manufacturing and company strategies (Skinner, 1969). Figure 1 illustrates how these initial influences have led to many of the core concerns of operations management.

By the 1980s the discipline of operations management had become firmly established both in the US and the UK. Reviews of the content of operations management were conducted by a number of people including Buffa (1980) and Voss

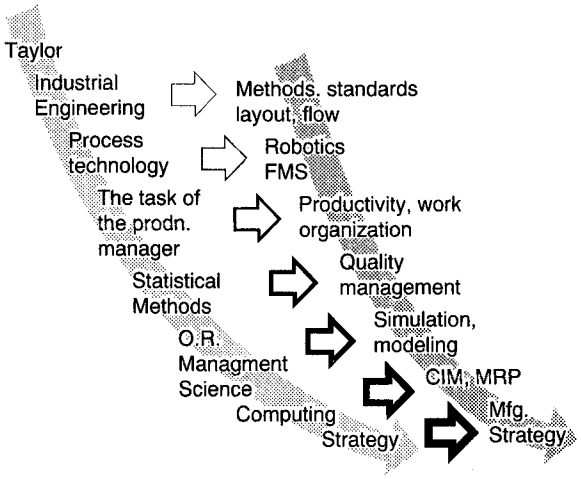

Figure 1. The development of management (FMS, flexible manufacturing systems; OR, operations research; CIM, computer integrated manufacturing; MRP, manufacturing resource planning)

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Table 1. The content of operations management in the 1980s

	Buffa (1980)	Voss (1984)
Production planning and inventory control	x	x
Purchasing	x	x
Facilities	x	x
Process design	x	x
Process technology		x
Job design, work organization	x	x
Organization structure	x	
Management of technical change		x
Maintenance and reliability	x	x
Quality control	x	x
Work measurement	x	
Manufacturing policy		x
Cost estimation		x
Systems approaches		x
Physical distribution		x
Service operations		x

(1984). The results of these reviews are summarised in Table 1. As can be seen there is a set of topics that are familiar today and found in most standard textbooks. In addition, there was considerable focus on the use of analytical and quantitative techniques in manufacturing, for example critical path methods, linear programming, lot sizing, etc.

The 1980s Research Agenda

The establishment of a strong and distinctive discipline was complete by the end of the 1970s. By 1980 scholarly journals had been launched in the US, the *Journal of Operations Management*; and in the UK, the *International Journal of Operations and Production Management*. This strengthening of the identity of operations management in the 1980s led to a number of groups reviewing and developing the research agendas for the area (Chase 1980; Miller *et al.*, 1981; Voss, 1984). Both Miller in the US and Voss in the UK developed very similar agendas; these are summarized in Table 2. They both identified five areas of focus: operations policy, which included manufacturing strategy and identifying causes of success and failure in operations; operations planning and control where there was a major need for further development and understanding of the newly developed production planning and control systems; service operations, by the 1980s it had become clear that operations management principles could be applied equally in services; productivity and technology, the early 1980s was dominated by the rapid emergence of new manufacturing technologies and by the realization that implementation was a serious managerial task; quality, this was on both research agendas although the full advent of total quality management (TQM) had not been seen or anticipated. Voss also recognized the advent of the Japanese influence and included this in his research agenda.

Patterns of Research in Operations Management

The development of and debate on research agendas in the early 1980s led to an increasing

Table 2. Research agendas for the 1980s

	Miller (1981)	Voss (1984)
Operations policy	Strategies of successful firms Strategic decisions in technology procedure and organization	Policy performance relations Performance measurement Identify transferable Japanese practices
Operations control	Design and implementation of Production Planning and Inventory Control Congruence of operational goals with performance measurement and rewards	MRP and supplier performance
Service operations	Managing customization Positioning strategy	Non-manufacturing systems
Productivity and technology	Evaluation of emerging process technology Determinants of productivity Long-term implications of new technology	Implementation Diffusion of innovations Developing flexibility
Quality	Quality of life	Management structures to overcome quality weakness

Table 3. Ranking of frequency of research papers by type of research

Rank	US	UK
1	Modelling	Conceptual
2	Simulation	Field
3	Conceptual	Survey
4	Survey	Case
5	Case	Modelling
6	Field	Simulation

volume and variety of research in both the UK and US. In the last few years there have been a number of detailed reviews of this research (Amoako-Gympah and Meredith, 1989; Neely, 1993; Heylen and van Dierdonck, 1994; Minor *et al.*, 1994). It is not the intention of this paper to repeat their work but it is instructive to review some of the key patterns.

Over the past decade there would seem to have been different patterns of research in the UK and US. A review of papers published in the *Journal of Operations Management* and the *International Journal of Operations and Production Management* shows sharp contrasts between US and UK research types. When ranked by number of papers of each research type, US publications are dominated by modelling and simulation research with 69 per cent of papers falling in these categories. UK research on the other hand is dominated by conceptual, field and case-based research, with 80 per cent of papers in these areas (see Table 3).

There are potential strengths and weaknesses arising from the patterns in each country. US research has been dominated by the quantitative background of the subject and journals in that country. It could be argued that US research in the 1980s was dominated by the 1970s research agenda and failed to respond to the new challenges identified by Miller and others. In particular the lack of empirical research has come in for increasing criticism. In 1989 the *Journal of Operations Management* had featured a call for empirical research-based papers. In recent years there have been a number of papers describing, discussing and encouraging empirical and field research methods (Flynn *et al.*, 1990; Meredith *et al.*, 1989; Meredith, 1993; Platts, 1993; Swamidass, 1991).

UK research on the other hand has been strongly influenced by research funders such as the Engineering and Physical Science Research Council (formerly the Science and Engineering Research Council) and industry. These have put much emphasis on the need to have widespread applicability in industry and on conducting research in the field. As a result UK research would seem to have been more reactive to the research agendas of the 1980s. A review by the author of the topics of papers in the *International Journal of Operations and Production Management*, dominated by European contributors is shown in Table 4. In contrast to the US concerns with developing empirical methodologies, the concern

Table 4. Level and trend of publication rate in the *International Journal of Operations and Production Management* by topic

	Level		
Trend	Low	Medium	High
Up	Maintenance Research methodology	Quality Practice performance Cellular manufacturing Flexibility Performance measurement	Lean production/Just-in-time Manufacturing strategy Implementation
Static		Service Flexible Manufacturing Systems/ Advanced Technology Computer Integrated Manufacturing	Models Simulation Production Planning and Inventory Control
Down	Economic Order Quantity Buffer stocks Optimized Production Technology Robotics	Manufacturing Resource Planning	

in the UK is more about the possible lack of rigour in research in this country.

Whereas the late 70s and early 80s were dominated by new technologies such as robotics and computer-integrated manufacture, and production planning and inventory control systems such as Manufacturing Resource Planning (MRP) and OPT, from the mid 1980s operations management was dominated by manufacturing strategy and by Japan. The increasing understanding of the Japanese influence on manufacturing can help us understand the evolution of operations management.

From Taylor to Toyota – The Development of Lean Production

The production management approaches of Japanese companies have been given many names. In Japan they were and are still known as 'Toyota Production System' (Sugimori *et al.*, 1977). In the West, the term just-in-time management has been widely used. However, as it does not accurately reflect the full scope of Japanese approaches, many others have been used including 'continuous flow manufacturing', 'world class manufacturing' (Schonberger, 1987) and most recently and probably the best term, 'lean production' (Womack *et al.*, 1990).

The evolution of lean production illustrates well the current nature of operations management. First, despite the novelty of the approaches it has its roots in the core approaches underlying the area. Taylor, the development of reproducible processes, Henry Ford and others contributed to the development of mass production that has dominated much of this century. In moving beyond mass production, lean production has drawn upon rather than rejected much of the core. Some observers have been struck by the degree to which traditional industrial engineering approaches of measurement, layout and job design underlie much of the detailed development of new approaches in Japan. Single minute exchange of dies (SMED), at the core of batch size reduction and lean production, is a process in the true tradition of industrial engineering. The little discussed but highly influential technique of total productive maintenance has its roots firmly in the core of operations management. Similarly the statistical methods of Shewhart, developed by Deming and Ishikawa are at the centre of quality management in lean production. It was a Russian development, namely group technology that underpinned much of the move towards cellular layout and design.

A key element in the development of lean production has been the organizational side, and in particular the role of teams and the individual. In batch production, teamwork has been an essential ingredient in the successful move from simple group technology to cellular manufacture. SMED and total productive maintenance owe their effectiveness to team-based approaches. New ways of thinking about the roles and responsibilities of individuals at all levels from top management to the shop floor has been the basis of the move from quality control to total quality management. The convergence and rethinking of a number of core areas of operations management, together with the combination of new ways of organizing and managing has led to the ability to develop processes that are of high quality, predictable, reliable and flexible. This in turn has been a key enabler in the move from mass to lean production. This is illustrated in Figure 2.

This evolution illustrates three key elements of operations management in the 1990s.

The Core. Operations management has a core that is both developing continuously and provides a strong input into new areas and approaches. Teachers and researchers in the area ignore this core at their peril.

The Interface. Many of the new developments in the field come from the interface between operations management and other disciplines such as behavioural science, information management and strategy.

Convergence. New approaches such as lean production do not result from individual breakthroughs, but from the convergence of many new and existing approaches.

Taking the perspective of Taylor to Toyota also helps to highlight the distinctive character of operations management. In our area, we think of Taylor (and his contemporaries) in terms of the contribution to the theory, science and practice of the area. On the other hand, many behavioural scientists and others think in terms of Taylorism, the negative impacts of command and control styles of management. Similarly, those concerned with Taylorism are also concerned with Japanization, the negative impact of new working methods.

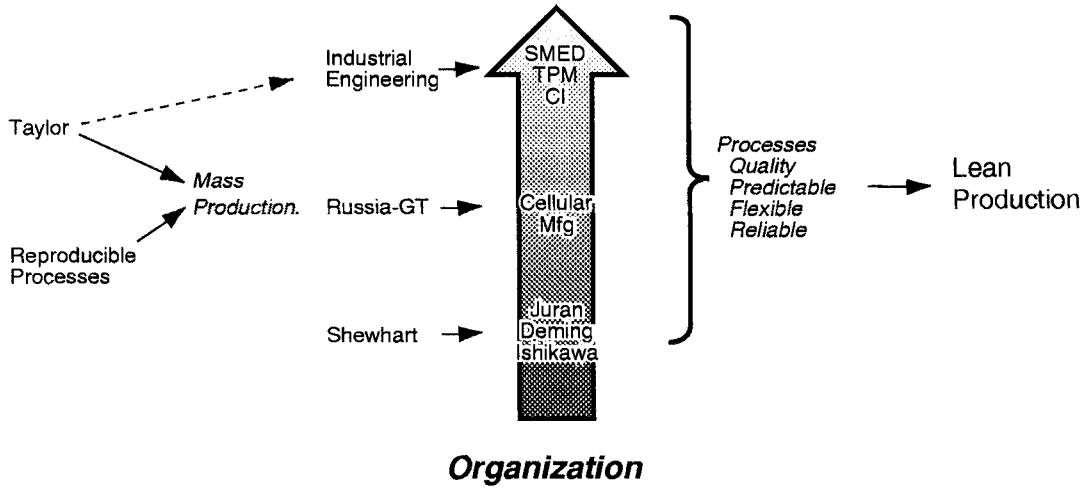

Figure 2. Evolution of lean production from Taylor to Toyota (SMED, single minute exchange of dies; TPM, total productive maintenance; GT, group technology)

However, there is hardly a major technology or innovation that does not have a social impact. The distinctive contribution of operations management should not be the neglect of the social side and implementation, but rather it should, through in-depth understanding of the operational core of areas such as lean production, be able to work with other disciplines in understanding the wider impact of the introduction of new ways of managing operations. The terms Taylorism and Japanization can be seen as a reflection of the performance and pervasiveness of their approaches. It is only because that they are so operationally effective and widely adopted that enough attention has been paid to their social implications to merit their own names.

Operations Management as an Interface Discipline

In the previous section it was argued, in the context of lean production, that operations management is characterized by both a strong core and the interfaces with other disciplines. This is demonstrated in an ever increasing range of concerns of the researcher in the area. The following illustrates some of the recent areas of research based on multiple disciplines.

Simultaneous Engineering. Research in this area has focused on the process of developing new products quickly and effectively. The key interfaces include those with engineering where new processes such as rapid prototyping are being developed; organization where teamwork and communication underpin the area, and information management where news systems such as computer-aided logistics systems are being developed.

Business Process Redesign. Much of the work in this area is being done in the information technology arena. But as Davenport and Short (1990) argued, it is the 'new industrial engineering' drawing on the process management and design disciplines of operations as well as information technology and organizational redesign.

Mass Customization and Computer-Integrated Manufacture. The growing sophistication of the use of computer systems in manufacture has led to the development of new approaches allowing high variety at low or reasonable cost (Pine *et al.*, 1993; Westbrook and Williamson, 1993).

The Virtual Factory. The use of information technology and the increasing sophistication of international logistics management, coupled with flexible, customized manufacture has led to much speculation about the possibility of developing the virtual factory; the ability to configure a network of plants and development capability to meet a specific need or project (Davidow and Malone, 1993).

Performance Measurement. Performance measurement has long been of concern to managers of operations. Increasing criticism of the negative effects of traditional accounting methods has led to attempts to bring operational and accounting approaches together. An example of this in service industries is the work of Fitzgerald *et al.* (1993).

Figure 3. Operations management (OM): the move to the interfaces (CIM, computer integrated manufacturing; TQM, total quality management)

Service Management. The management of service has for some time been recognized as a key interface between marketing and operations. Because of the simultaneity of production and consumption, the two are not easy to separate.

Manufacturing Strategy. Writers in manufacturing strategy (Skinner, 1969; Hayes and Wheelwright, 1984; Hill, 1985) have placed a strong focus on the relationship between the market place, the competitive strategies of an organization, and the operational choices in structure and infrastructure. Similar links are also being developed in operations strategy in services (Heskett *et al.*, 1994).

These are a subset of the interface areas in operations management. Others include total quality management, continuous improvement, implementation of new technologies and the competitive impact of operations capability (see Figure 3).

Buzz Words or Paradigm Shifts?

Operations management is probably the prime producer of three letter acronyms. We have seen MRP, TQM, TPM, OPT, JIT, SPC to name but a few. A frequent criticism is that many of these are short-lasting fads, rather than enduring changes or paradigm shifts. However, on examination it would seem that most of them have endured, though not necessarily in the same form. A study of manufacturing practices and performance in Europe by Hanson *et al.* (1994) concluded that 'world class' firms did not adopt a subset of practices, but the full set of what could be considered best practice. There would seem to be a life cycle of new approaches. Initially, they are widely communicated and adopted, often as part of a programme or initiative, and often in isolation. Considerable learning takes place, with necessary modification and development, and if ineffective they are discarded. During this process, we can learn about the context and contingencies, under what conditions they are appropriate. Some evolve, in the case of MRP from materials requirements planning to manufacturing resource planning, and then revert. In this case it became clear than under a lean production environment simple MRP could be more effective.

Most importantly, programmes frequently evolve from stand alone initiatives to being part of the standard toolkit of operations. In doing so their fit with each other becomes clearer and better understood. In the best companies, new practices become embedded in the way that they manage. For example, few of the exemplars of 'total quality management', use these words explicitly or have total quality management programmes, rather they have embedded the various practices and attitudes that go to make up total quality management (Binney, 1992).

It would seem that we are observing both buzz words ***and*** paradigm shifts. New ideas and practices become associated with buzz words and programmes or initiatives; but in the long run, if effective, the buzz words disappear and genuine shifts in ways of thinking and working take place. This is a process in which operations management researchers have an important role to play.

2. Operations Management – Current Issues

The Relationship with Industry

Operations management is very much an applied discipline; unless its output influences, advises and helps industry to improve it is not effective or of value. Operations management has a symbiotic relationship with industry. First, industry is a major source of ideas, needs and issues and hence problems to be worked on. Many operations management researchers, strongly encouraged by the principal funding bodies, look to industry for research agendas. Second, industry can be a laboratory. There are strong national contrasts in this area. On the one hand, much US research never takes place anywhere near an operation, relying strongly on simulation and other analytical methods. On the other hand, in Sweden massive experimentation has been done in industry, a prime example of which was the Volvo plant at Udevalla. This was a massive, and ultimately unsuccessful experiment, but one from which a large amount of new knowledge has emerged (Engström and Medbo, 1994). In the UK there is some use of factories as laboratories. This particular aspect of research has been fostered in the UK by the Science and Engineering Research Council (now the Engineering and Physical Science Research Council). A prime requirement for funding is testing and application in industry, often accompanied by a 'how to do it' work book.

This at first sight seems, and generally is admirable. There are however a number of issues. First, there is a danger that getting too close to middle-rank companies may generate the wrong research. It is possible for companies to indicate needs to which there are already well developed solutions. In contact with industry, researchers must, on the one hand, distinguish between genuinely unanswered questions, potentially novel solutions and improvements; and on the other, industrial issues and problems cause by lack of diffusion of new knowledge or inability to implement new approaches by companies. The latter is often common in the UK and other European countries. A field study of 663 European companies found that only about 4 per cent had effectively adopted the current known best practice, and over 50 per cent were significantly behind in many areas (Hanson *et al.*, 1994). A result is that much research funded in the UK may more accurately be described as communication of existing knowledge and support of implementation. Operations management academics must be prepared to be intellectually honest when dealing with firms that are slow adopters, poor implementors, poor problem diagnosers or solution specifiers.

Another risk arises from research that seeks to identify best practice through field study of the operational determinants of performance. This model has been at its most effective in the automotive field, for example, the International Motor Vehicle Programme (Womack *et al.*, 1990), and in the work of Clark and Fujimoto (1991) on new product development. However, this type of research has two limitations. First, if conducted in a purely UK or even European context, there may not be sufficient firms from which to identify best practice. Second, even when good practice can be identified, unless there is real time dissemination and/or a positive effort to build upon and improve it, it may be yesterday's best practice by the time of publication.

Despite these potential problems operations management research by its nature must come from and/or be tested and implemented in the field. The global nature of operations and the multiple sources of new ideas indicate that field studies should be increasingly international in scope and not confined to one country or region.

Raising the Impact of Operations Management Research

The changes over the last 15 years in the way that operations are managed have been massive, and this has been reflected in major changes in product and operational performance. However, it is salutary to reflect that some of the most influential books in the area have been written by people outside the field such as economists. Such an example is the book by Womack *et al.* (1990) on lean production in the automotive industry. It has

influenced senior managers in the industry as much as any previous research; why is this so? It can be argued that the first reason for this is that it has a firm focus on the business outcome of new ways of managing operations, a process-outcome approach. Empirically demonstrated relationships between practice and operational and business performance can have a high impact in the business and academic community. A second reason for the impact is that it was both global and thorough, giving a greater validity to its results. There are a number of lessons that we can learn in operations management. High impact is likely to come from:

– **Linking process to outcome**, in particular business outcome. In part this means talking the language of business. The influence of Hill's (1985) manufacturing strategy work in the US is a reflection of this.

– **Empirical and large-scale research**; effective process-outcome research cannot be done with small samples. This is witnessed by the paucity of research showing links between total quality management and business performance.

– **International research**; comparisons between and learning from a wide range of backgrounds are likely to lead to richer and more valid results.

– **Theory development**; such research may revert to benchmarking unless there is an underpinning of theory testing and development.

– **Multiple disciplines**; as argued earlier, operations management research is often conducted at the interfaces with other disciplines such as information management, industrial economics, accounting and behavioural science. Effective collaboration can lead to greater impact.

The Need for Aggressive Agendas

As argued earlier, operations management research in the UK has responded effectively to the agendas of the last decade, and has evolved to take on board the new agendas driven by the transfer of predominantly Japanese practices during the last 10 years. However in looking towards future research agendas we should not take our eyes off our international competitors. Today's research must enable the UK and the rest of Europe to compete with their competitors in the future 10 years. It is instructive to look at Japan. In a recent review of Japanese manufacturing strategies, Yamashina (1994) indicated that there have been considerable changes. First, the continuing strength of the yen has placed enormous cost pressures on Japanese firms. They see real competition coming, not from the West, but from the new Asian 'tigers' such as Taiwan, Korea and Hong Kong. Their response varies depending on the context of the firm. Central to this is the search for ways of generating massive cost reductions. This has led to a move away from time-based competition and putting on hold approaches such as mass customization. These despite popular assertion have a cost attached to them. Instead, research is focusing on how to take costs out with radically simpler design, exploiting new techniques such as total productive maintenance and other new methods of manufacturing. Targets of 30 per cent cost reduction over a 4 year period have been quoted. Many Japanese organizations are rapidly moving to internationalize their manufacturing operations. Other are also following the well established route of keeping a substantial technological lead in their products thus enabling margins to be maintained despite the strong yen.

It is also instructive to look at manufacturing strategies within the Asian tigers. The popular belief is that they are primarily focusing on low cost. This is a major misrepresentation. They have had a history of low costs due to the wage levels of the country. The focus in these countries is on learning; the development of new skills and new technologies. Large companies are massively investing in learning; for example Daewoo in Korea has in a short period of time acquired the product and process technology and capabilities necessary to become a player in the world automotive industry, and has recently announced plans to produce 2 million vehicles per annum. Both large and small manufacturing companies in countries such as Korea, Singapore and Hong Kong are involved in bilateral and more complex networks with Original Equipment Manufactures (OEMs) and suppliers in other countries. A major objective for many of these companies is to learn through these relationships so that they can develop the technologies and skills to stand alone and compete against their former customers and suppliers. There may be as much to learn from the small Asian company as from the Japanese giant.

The implications of the above are important. If for example, Toyota was to reduce its product costs by 30 per cent, what would be the impact on

European manufacturing? What research agendas are needed to prepare for this? If small manufacturing enterprises (SMEs) in Singapore and Hong Kong think globally and are able to use the supply chain to learn rapidly, what are the research implications with regards to UK SMEs. It could be that we risk not being ambitious enough. Through focusing on how to help companies, in particular SMEs, adopt proven technologies in order to survive, we neglect the fundamental questions of how do we make our SMEs into learning organizations that can compete globally. Learning is beginning to be recognized as an important focus for manufacturing (Leonard-Barton, 1992). It is likely that research agendas based on competing with the East are likely to be more aggressive than those based on European views alone.

3. Some Future Directions

Towards a Linked and Tested Theory of Manufacturing Strategy

There is a need for continued research to provide stronger empirical underpinning of current theories. This is beginning to be done in some areas such as total quality management (Dean and Bowen, 1994) but in others theory lags practice.

It has been argued elsewhere (Voss, 1995) that manufacturing strategy is composed of a number of separate elements: competing through manufacturing, strategic choices in manufacturing (a contingency approach) and best practice (see Figure 4). Though some authors link parts of these, particularly the first two, there is no clear overall theory of manufacturing strategy linking all three. Most of this theory has been developed from the evidence of case studies. There is growing detailed empirical evidence of best practice approaches, and for example generic manufacturing strategies (Miller and Roth, 1994), but overall there is little systematic empirical research. Some key assertions such as focus have not had good empirical testing; and some of the contingent approaches have not moved substantially beyond Woodward. There is a need to develop both a more unified theory of manufacturing strategy which reconciles more closely the conflict between contingent approaches and best practice approaches. The growing debate on resource-based theories of strategic management (Dierickx and Cool, 1989) may inform and in turn may be influenced by manufacturing strategy. Powell (1995) has reviewed total quality management in the context of resource-based theory. Much of a firm's resource is the capability of the operations, not just total quality management, but a wide range of areas.

Exploring Contingencies

One of the main roles that operations management researchers can play is to explore the contingencies associated with new approaches and their implementation, see for example Benson *et al.* (1991) in the field of quality management. Study of manufacturing practices in Europe (Voss *et al.*, 1995) illustrates some potential contingencies that need exploring. First, when examining the impact of the site size, one finds that the level of adoption increases with site size, whilst the level of performance from implementing practices decreases. Is this because new practices do not deliver? The evidence is against this; in all areas studied, adoption of 'best' practice led to improved performance, and overall over 50 per cent of operational performance could be explained in terms of practice (*see* also Oliver *et al.*, 1994). It raises two

Three paradigms of manufacturing strategy

	Competing through manufacturing	Strategic choices in manufacturing	Best practice
Key concepts	Order winners Key success factors Capability Generic manufacturing strategies Shared vision	Contingency approaches Internal and external consistency Choice of process Process and infrastructure Focus	World class manufacturing Benchmarking Process re-engineering TQM Learning from the Japanese Continuous improvement
	Process		
	Measurement		

Figure 4. Composition of manufacturing strategy (TQM, total quality management). Source: Voss (1995)

questions: to what degree should practice be contingent on the type of the firm, for example its size; and to what degree do different firms have different implementation agendas? At a different level, Abo (1994) describes what he calls 'the hybrid factory'; the Japanese factory in the US. He argues that Japanese companies when building factories overseas adapt their methods and management styles to match the local context. Their work raises a more general issue as to how the national manufacturing context shapes manufacturing choices.

Implementing Multiple Initiatives

Operations academics and practitioners continually develop new approaches, but without effective implementation, even the best may have little impact. Powell (1995) argues that

> 'Both the anecdotal and statistical evidence suggest that, although TQM can produce competitive advantage, adopting the vocabularies, ideologies, and tools promoted by TQM gurus and advocates matters less than the intangible resources that make TQM implementation successful'.

There are a number of reasons why we must look beyond a simple view of implementation. Hanson *et al.* (1994) show that 'world class' factories are characterized by good practice in ***all*** areas. Borrowing Hill's terminology of order winners and qualifiers, we can argue that having good practice in all areas is a qualifying criterion for staying in business. If this is so, moving to this state invariably requires companies to implement multiple new approaches and technologies over a period of time, and sometimes simultaneously. This raises for the individual organization management questions such as where do we start, and in what order do we implement new practices? On the one hand, Ferdows and De Meyer (1990) have argued that, in order to achieve lasting improvements in manufacturing, there is a correct sequence for implementation that starts with organizational change. On the other, Voss *et al.* (1995) state that implementation agendas are contingent on the starting point of the company. They argue that a factory that is starting from a poor position will have as the key question – what to do first; the factory that has tried to implement without success one or more initiatives will have an agenda that might include implementation skills, alignment with the company's market objectives and between initiatives.

To date most implementation research has focused on single areas such as MRP, TQM or CAD/CAM. However, the aforementioned evidence implies the need to consider implementation of multiple initiatives, and the need for different implementation approaches depending on a company's starting point. This, as yet, is not fully explored.

Strategic Integration with Engineering

Companies are increasingly competing through their ability to manage the whole cycle of product realization and delivery from the initial concept through to delivery and support at the customer. Increasingly, both the cost and quality of a company's products are determined, not in the manufacturing process, but in its design and its components. They are doing this through managing an integrated company, not a set of separate functions. This raises a major challenge to the field of operations management. There are now increasingly strong arguments for seeing engineering and manufacturing together as a single unit in developing the operations capability of the firm. Manufacturing firms are increasingly thinking in terms of and competing through their manufacturing systems, not manufacturing alone. Manufacturing strategy approaches will need to evolve to be fully integrated with engineering. This will require amongst other aspects the identification of the key strategic choices in engineering and the factors that determine these choices.

Service – Learning from Marketing

In the 1980s, led by Chase and others, there was a major emphasis on transferring the knowledge base of manufacturing to service, and to building a distinctive view of the operational approaches in a service environment. This was followed by the growing identification of the service elements of manufacturing, and the realization that service could add value regardless of context. Over the past decade a distinctive discipline of service management has begun to emerge, informed as much by marketing, organizational behaviour and strategy as by operations. Service management because of the simultaneity of production and consumption has always been cross-disciplinary. The challenge in operations will be to build on the work done in other areas. For example in

marketing, new approaches to quality management have been developed (Zeithaml *et al.*, 1990). These are not always consistent with more established total quality management approaches. For example, the literature on service recovery contrasts with the manufacturing zero-defects approach. To date, although service quality concepts are well known, there has been remarkably little transfer from service management to traditional operations management. Another opportunity is in the models such as those developed by Heskett *et al.* (1994). Their 'service-profit chain' model presents a service-based equivalent to manufacturing strategy models. As with manufacturing strategy, it is based on case research and presents an opportunity for more extensive empirical research to validate and extend it.

Conclusions

Core Reinforcement and New Interfaces

In reviewing the aforementioned discussion, we can return to our previous view of operations management – that it has a core, that it works at the interface and that convergence of multiple ideas lead to new approaches:

The Core Reinforced. Operations management's heart lies in its core, the development and management of value-adding processes, and the tools, techniques and methods to support this. If operations management is to continue its role it must not neglect its core, but must continually search for new approaches and improvement of its existing ones. It is only from the strength of its core can operations management contribute effectively to the existing and emerging interface areas. The current scope of the core can be illustrated by the list of topics that reviewers of the *Journal of Operations Management* have been invited to express interests and expertise in 1995. These are listed in the Appendix.

New Interfaces. Many of the new interface areas have already been explored in this paper. They include: the exploration of contingencies in manufacturing strategy and implementation; improvement programme choice and manufacturing; the relationship between practice and performance in both service and manufacturing; learning through international networks, particularly at the SME level and strategic integration with engineering. Other possible areas include: building on current performance measurement work with accountants in the development of performance planning and target costing; and the refining of process management, in particular bridging the potential divide in this area as applied in total quality management and business process redesign. These are summarized in Figure 5.

Convergence. New areas for convergence will emerge, probably with information management as one of the key integrators. Networking may

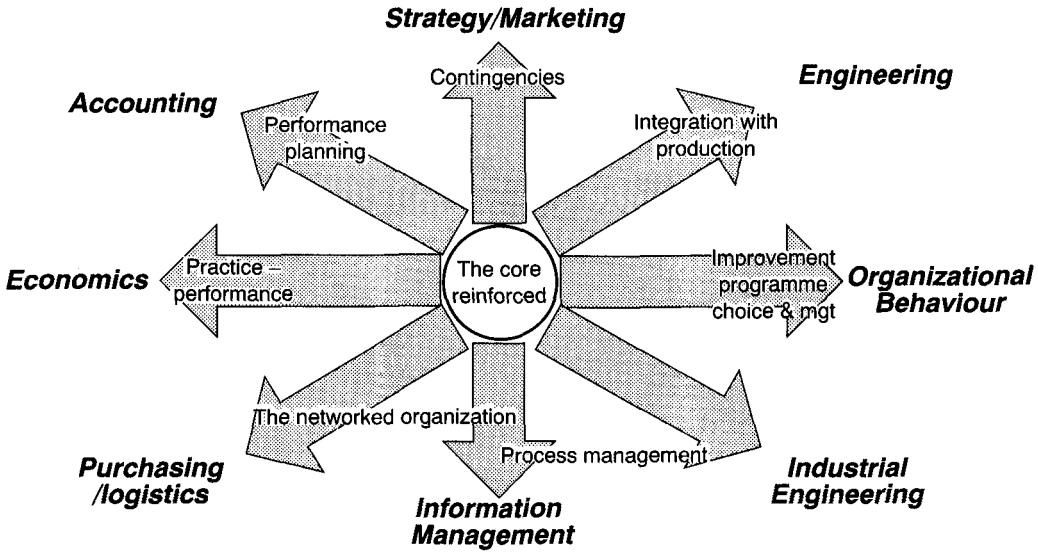

Figure 5. Future interfaces in operations management

become a platform upon which convergence of the 1990s will occur. A further agenda may be generic research into the mechanisms whereby the core and interface areas operations management can be linked. This will help in exploiting the core of operations management to the full.

In summary, operations management sought to respond to the challenges put forward in the 1980s and in doing so has created new agendas for the 1990s. To be successful, research will build theory and test it; it will try to influence business leaders as well as plant managers and engineers; it will continually build its core and use this as a platform for being an effective partner at the interface. Operations management has always been the guardian within the business school context of the management of the value-adding processes. These have evolved continuously from Taylor to Toyota, and are continuing to evolve. If Frederick Winslow Taylor was alive today, he would approve.

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Appendix

Core Areas of Operations Management

List of topic areas for reviewers of the *Journal of Operations Management* (1995)

Automation
Facility location
Group technology
Kanban
Logistics
Production planning
Quality management
Statistical process control
Aggregate planning
Cellular manufacturing
Focused factory
Forecasting
Job design
Manufacturing control systems
Materials requirements planning
Process industries
Repetitive manufacture
Staffing
Work measurement
Assembly line balancing
Facility design
Flexibility
Job shop scheduling
Master production scheduling
Product development
Purchasing
Shop floor control
Yield management
Decision/risk/utility/AHP
Probability/statistics processes
Programming/optimization
Capacity management
Flexible manufacturing systems
Just-in-time
Maintenance/reliability
Materials management
Project management
Service operations
Warehousing
Batch manufacturing
Environmental issues
Flow shop
International issues
Lot sizing
Mathematical programming
Process design
Personnel/workforce/shift scheduling
Safety/health issues
Theory of constraints
Re-engineering
Dispatching
Facility layout
Inventory management
Lead-time
Operations strategy
Productivity
Scheduling sequencing
Vehicle scheduling
Queuing
Heuristics
Regression/factor/cluster analysis
Simulation