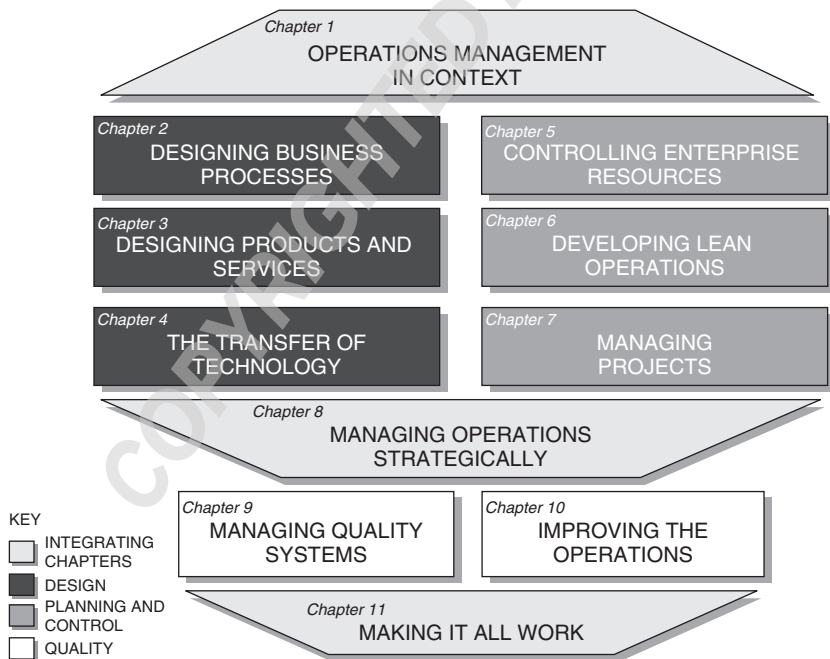


1 OPERATIONS MANAGEMENT IN CONTEXT



Conceptual model of operations management

Introduction

The aim of any service, public sector or retail or industrial operation is to deliver goods and services of the quality, quantity, cost and availability that will satisfy the customers' needs while at the same time making most effective use of resources. This can only be achieved by giving attention to the design of products, processes and work for employees, and through competent planning and control. This is what Operations Management is about. This book presents the fundamental principles of operations management in a novel and structured way that is appropriate to the needs of contemporary Operations Managers, and students in this field.

Operations management covers decision making in the organization, from top level management issues such as developing an operations strategy congruent with the company's business and marketing strategies, to the immediate control of operations. It is, therefore, more than operational management. Each chapter develops an understanding of the theory and practice of key operational concepts to enable delivery of the strategy.

The book is structured in a unique manner, to better reflect the concerns of the contemporary Operations Manager in the twenty-first century. The book is based around the conceptual model of operations management.

The model centres upon the idea that operations management comprises three essential components:

1. *Design of operations* processes, products and services, and the work of individuals;
2. *Planning and control* of operations once designs are in place and operational; and

3. Ensuring *quality* of products and services produced and delivered, and (wherever possible) improving on these.

However these cannot be addressed in isolation. The essential element in *effective* operations management is the *integration* of these components. The book therefore contains three integrating chapters:

1. We need to understand **operations management in context**. What is its purpose in a business sense? And how and where does it relate to the other business functions.
2. How might we **manage operations strategically**? Design, planning and control activities must not be conducted totally independently of one another, so we need the means to coordinate our activities within a formulated operations strategy. We believe that operations strategy is best covered not at the start or end of the text (as you find in most other operations management books), but in the middle, after the principles of design and operations planning and control are well understood.
3. We need to consider the implementation of the principles contained in this book, so we need to look at **making it all work** in the final chapter. Implementation is identified by practitioners as the most critical activity, but is often overlooked or skimmed over in texts, so we address this head-on in this book.

The conceptual model offers a comprehensive and up-to-date view of the operations management function and it can be seen that we have integrated contemporary topics such as technology transfer, project management and lean operations (often discussed and also critical in business, but often overlooked in any depth within existing texts). But, before embarking on

these topics, it is important that we fully grasp and comprehend what the practice of operations management comprises, and also where it has evolved from in an historical and theoretical context.

Basic principles of operations systems performance

The task of the operations manager can be summarized at a basic level as converting a range of resource inputs, through the operations process, into a range of outputs in the form of products. However, the various elements that together make up this management function are diverse and complex in nature. The operations manager must have competencies in human resource management, strategic awareness, product knowledge, systems and organizational design and, at the operating level, of planning and control. Moreover, the task of the operations manager is often misunderstood and is often relegated to a reactive rather than a positive and proactive role within the organization. To indicate the importance of the operations function to the business it is useful to identify five key performance indicators for any operations system. These are quality, speed, dependability, flexibility and cost, where:

1. *Quality* reflects the extent to which operations are performed in line with specifications and/or satisfy the customer (i.e. *getting things right*);
2. *Speed* reflects how quickly and responsively we supply and deliver our products and services (i.e. *doing things quickly*);
3. *Dependability* indicates our reliability to the customer or recipient of the product or service (i.e. *doing things consistently and on time*);

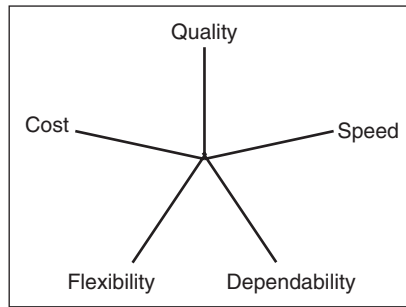


Figure 1.1 Five key performance indicators (KPIs)

4. *Flexibility* reflects our ability to adapt and respond to differing needs (i.e. *being able to change what we do*); and
5. *Cost* reflects the expense we have incurred in a financial sense to deliver the product and/or service to the recipient (i.e. *doing things cheaply*).

In a simplistic sense, and in the ‘ideal world’, we might argue that an operation should seek to optimize all five of these performance objectives. If an operation delivers the best quality, in the fastest time, more reliably, in the most flexible way and at cheapest cost, it is inevitable that this operation would perform better and therefore more effectively than its competitors. However this is a panacea. As Hill (1993) originally, and others have since argued, operations management comprises a set of ‘trade-off’ decisions, whereby a decision to improve performance for one indicator often (though not always necessarily) results in a negative effect on another. Most obvious in this respect is cost. Often decisions to reduce cost can impact upon quality, speed, reliability and flexibility if improperly thought through. This book will, later, indicate where costs and other indicators might be simultaneously improved, but we need to recognize there are often *constraints* on what we might be able to achieve. And this indicates the second important factor of operations management: it

is about managing constrained resources (human, physical and financial) which places limitations upon what we can achieve.

In the same way as the performance objectives above in Figure 1.1 can be used to compare and contrast different operations systems, so can the 'four Vs'. Let's investigate each of these individually, starting with volume. Figure 1.2 shows low volume on the left-side of the continuum and high volume on the right. Operations systems producing low volumes of products and services invariably result in: low repetition of tasks; operations performing a large proportion of the job (and perhaps the complete set of activities); less systemization; high unit costs. The opposite applies to high volume operations: greater repetition, a greater division of work, greater systemization and lower unit costs through economies of scale. The other three Vs run counter to volume, with 'high' on the left-side and 'low' on the right. This reflects the tendency for low volume operations systems to have high variety, high variation and frequently higher visibility. So high variety operations, those that produce a wide range of products and services, offer flexibility, are able to cope with and match customer needs and tend towards higher unit costs. Low variety operations, producing more standard products and services, have the opposite features. Variation reflects

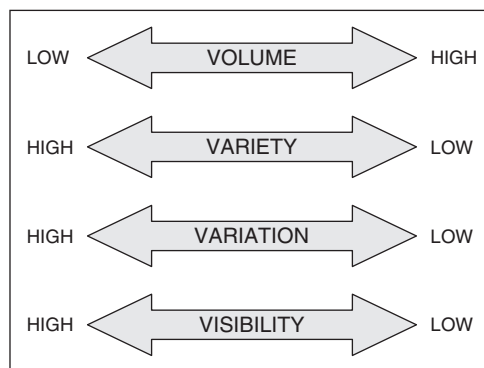


Figure 1.2 Volume, variety, variation and visibility (the four Vs)

ability of the operations systems to flex and change, usually in response to the nature of demand (frequent and rapid changes on the left-side, very stable, unchanging demand on the right. High variation operations systems feature the ability to change capacity of output, anticipation, flexibility response and generally high unit costs. Finally visibility reflects the extent to which operations facilities and workers are physically seen or capable of being monitored by customers and clients, or whether they are out of sight and contact (back office type operations). High visibility operations feature short waiting tolerance, the need for customer contact skills, variety and responsiveness in service, and high unit cost.

It has already been noted that the four Vs are arranged in Figure 1.2 so that volume has low on the left and a high on the right, whilst the others run opposite. This is for a reason. The features of operations systems occupying positions near the left-side of the continuum feature *flexibility* as a major concern: the ability to be flexible, to provide a flexible service. Whilst the right-side concurs with *repeatability*: the ability to economically produce products and services in high volume and at a relatively low unit cost. An example at this point serves to illustrate this.

Example 1

You have decided to take a vacation at an Island Resort. You wish to treat your nearest and dearest to a nice break in paradise; you want to be accommodated in a small house on stilts over the ocean. It's an oasis where people come out to you in little motor boats and cook meals for your family, then slip away to leave you in peace. You don't see anybody else. For this Island Resort volume would be relatively low, given our definitions above. The variety would be high. You expect them to provide a range of facilities. If you want to Jet Ski, they would be able to provide a Jet

Ski. If you want to go Scuba Dive on the coral reef, they would be able to arrange this, plus transportation and any necessary instruction. The cost to you might be high, but the Resort can supply this. Variation is potentially high for the Island Resort because of the unpredictability and needs for varied control systems for the services. Finally, visibility is high. You want to see a chef wearing the necessary outfit and hat preparing and cooking for them on a 'desert' island. You are likely to have a short waiting tolerance: if you are paying considerable amounts of money you want and expect efficient service now. The Island Resort, therefore, needs to design and plan their operations with the needs of its customers in mind. The Resort needs excellently designed and constructed accommodation and administrative buildings; staff with good customer contact skills; there is a need to recruit flexible employees who seem genuinely pleased to meet and greet customers and efficiently respond to their every need. All this comes at a high cost, but the customer is willing to pay for this.

Now contrast the Island Resort with a chain of Express Hotels, serving the needs of people who are on business or touring, and need to stay just one night, usually for about 8 hours. The Express Hotel needs to have a bed, a television, tea and coffee making facilities, and sometimes a telephone, not often though because we all have mobile phones. As a customer you need to be able to check-in and check-out quickly, and know that the room meets a standard quality. You don't care whether you see a member of staff or not. You just want to get into your room for the night, pay your bill and leave. You probably do not even want breakfast because you will take 'breakfast to go' with a coffee when on your way to your next destination. So, in contrast to the Island Resort, volume is high, because the

Hotel and customer alike require fast throughput and high repeatability. They are geared to a high volume of customers with very similar needs, and only willing to pay budget prices. Variety is low. Most of the Express Hotel chain's rooms look and feel identical. Variation is low because you, as the customer, are not expecting any differences. There is a stable routine, predictable operations and high utilization. Most of these hotels are located adjacent to major highway intersections so they are convenient and easy to get to. Visibility is low. Ideally you do not want to see anybody. After a long day's work or journey you are in no mood to talk to anybody and just want to soak in the bath or take a shower, then get a good night's sleep and depart.

To summarize, the four Vs are used within organizations to assess their operations. Organizations can profile customer needs across the four continuums, compare this to their existing facilities (where the operations are currently placed in terms of product or service delivery) and can also develop profiles for direct competitors. Such profiling enables *gap analyses* where, for example, one can identify any problematic differences between customer needs and actual delivery from our operations system, as well as benchmarking against competitors.

The scope of operations management

Operations management relates to that function of an organization concerned with the design, planning and control of resources for the production of goods or provision of services. As a discipline it is not merely confined to a collection of techniques and quantitative methods. It makes appropriate use of the tools of operational research and statistics where relevant, but is primarily concerned with the broader issues involved

in the design, planning and control of products, services and processes.

There are a number of ways of conceptualizing the scope of operations management, some of which are suggested below:

By considering the components of an operations system: Utterbeck and Abernathy's (1975) model of innovation suggests that any productive unit should be considered as comprising three main elements: product, process and work organization. It is useful to consider the operations manager as having responsibilities in all three of these areas.

By considering the life cycle for products: The operations management function is concerned with, and should have an input to, all stages in a product's life cycle. The product life cycle of introduction, growth, maturity and decline can be equated to a process life cycle, as illustrated in Figure 1.3. The responsibilities of the operations manager, therefore, should not be merely confined to the *production* stage, but to all stages of the product and process life cycle.

By considering the organizational scope of operations management: 'Operations management' should not be confused with the

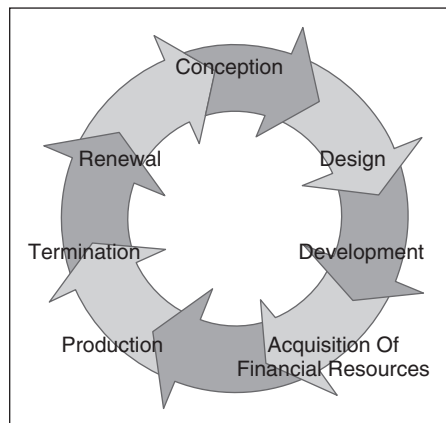


Figure 1.3 The process life cycle

term 'operational management'. The management of operations permeates all levels of organizational decision making and is not merely confined to less important, low level and short term decisions. The operations manager should, in turn, enter more widespread strategic debates in addition to maintaining contact with day-to-day operations. Thus the scope for operations management in decision making covers operational management right through to strategic management (see Figure 1.4).

The conceptual model employed in this book identifies and distinguishes 'design' activities from operations 'planning and control' and 'quality'. Design, covered in Chapters 2, 3 and 4, involves:

- *Business process design*: The organization and arrangement of physical facilities, information and material flows, and labour resources to enable the conversion of inputs (materials, orders, labour, etc.) into outputs (goods and services).

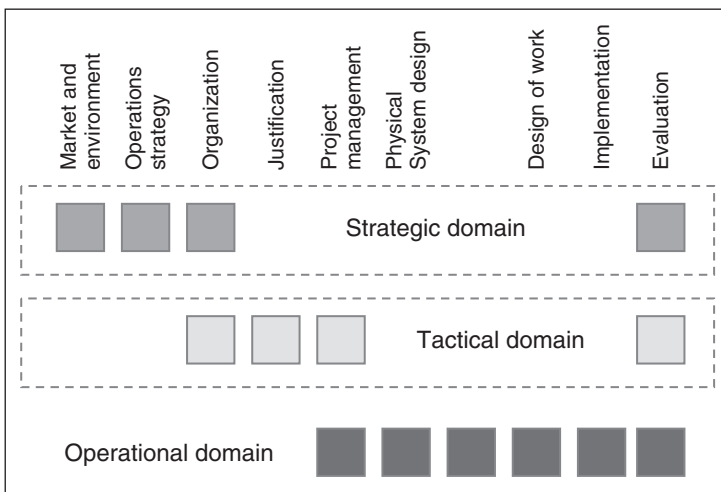


Figure 1.4 The levels of operations management decision making (Bennett and Forrester, 1993)

- *Product and service design*: Interrelated with process design, the configuration of the goods and services our processes are producing and delivering.
- *Technology transfer*: An activity frequently cited and identified as important, but often overlooked in other texts. Design activity will always involve the transfer of 'know-how' from one person, or group of persons, to others in the design process. This is true whether we are talking about new product or processes (research and development transferred from the 'laboratory' into regular operations) or the transfer of existing technologies (e.g. expanding operations, including establishing new facilities overseas based upon home operations, as part of an international operations strategy).

Planning and control is contained within Chapters 5 to 7. Planning and control concerns the organizing and monitoring of operations systems, projects and programmes, together with the feedback of variances from plan for process or programme adjustment where necessary. It includes:

- *Controlling enterprise resources*: The resources of the organization (its facilities, people and materials) need to be effectively managed in terms of operational schedules, workflow, materials management and throughput.
- *Developing lean operations*: The operations need to be managed in such a way that waste (of time, of resources, of money, of effort, etc.) are minimized. Lean operations have evolved in terms of theories and practice over the last two–three decades, so to be competitive organizations must grasp these principles.
- *Managing projects*: Linked with programmes of design and change management, there is a distinctive set of management principles for the coordination and control

of projects. This not only relates to the set of tools and techniques available, but most critically to organization, teamwork and management styles needed for effective project completions.

Quality management has been explored in depth and much written about over recent years. The main themes for operations managers include not only quality control, but also an emphasis on improvement. This is the reason why this book punctuates the chapters on design and planning/control from quality management chapters with the coverage of managing operations strategically (Chapter 8). Our argument here is that 'improvement' forms the core of any effective operations strategy, so the main strategy chapter should be placed here to integrate and link preceding principles from the improvement process covered later. The main principles of quality management, covered in Chapters 9 and 10, include:

- *Managing quality systems*: Quality control systems need to be effectively designed and put into practice, to enable the capture and evaluation of quality data and customer feedback, whether this data is quantitative or qualitative in nature.
- *Improving the operations*: Contemporary 'best practice' indicates that operations systems should not stand still, merely adopting quality management systems which measure whether performance conforms to prior specifications. Instead there should be an emphasis on *continuous improvement* whereby there is a commitment by the organization to future development of the operations.

The practice of operations and quality management is accepted as a necessary function within any organization. When one talks of a theory or discipline of operations management, however, it

has only been relatively recently that this has become accepted as an appropriate subject for academic study. The reason is perhaps explained by the range of competencies normally required by an effective operations manager: human resource skills, technical knowledge, problem solving abilities, logic, quantitative methods and strategic insight are all areas in which the manager should be conversant. As a result one single line of theory has not emerged within the discipline. The model presented in this book provides a structure for understanding operations in context, but it needs to be appreciated that operations management has developed using theories and principles from a range of other disciplines, as well as being rooted in its own tradition. The final section of Chapter 1, therefore, now conveys an historical understanding of the subject.

The evolution of operations management

Operations management will now be now set within its rich historical context. The major influences and developments in the subject over time will be highlighted. Figure 1.5 shows these historical influences in a chronological order and should be referred to in conjunction with reading the following text. It illustrates the history of operations management and shows the major influences upon the subject through its development.

Operations systems have always been in existence, albeit in different configurations to what one might expect to find today. Consider the ingenuity and industry involved in the following projects from history: Stonehenge on Salisbury Plain in the UK; the Egyptian Pyramids; the Great Wall of China; the cities, aqueducts and roads of the Roman Empire; and the programme of shipbuilding that preceded the sailing of the Spanish Armada in 1588. These would not have materialized without some form of operations management thinking.

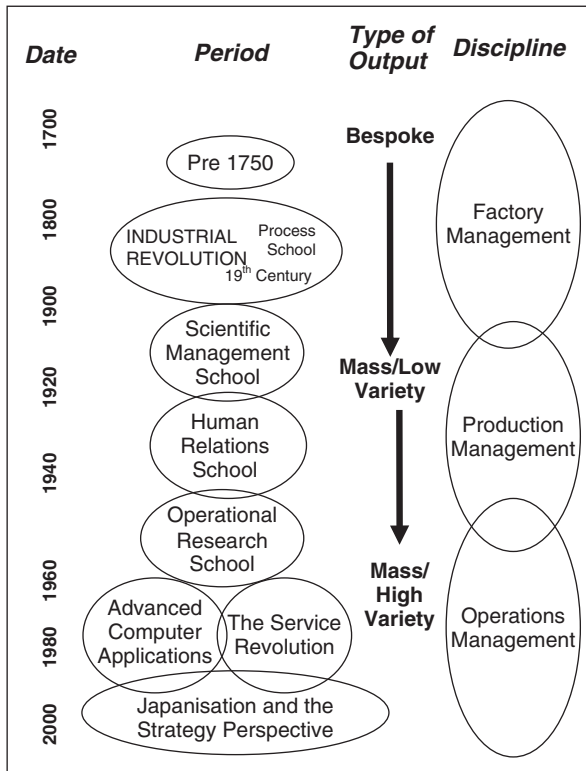


Figure 1.5 The evolution of operations management as a subject and practice

Prior to 1750 products were manufactured quite differently than they are today. Most production took place in the homes, cottages and workshops of independently trading craftsmen, hence the descriptive terms we tend to use nowadays of 'the cottage system' and 'cottage industries'. Production before the advent of the Industrial Revolution can be characterized by direct contact between producers and consumers, little mechanization, and the production of bespoke, custom-made and personalized products.

The Industrial Revolution began in England in the 1700s. The early years can be summarized by two principal developments.

Firstly there was a substitution of machine for human power. The inventors of machine power gave rise to the 'Process School' and their activities gave rise to the various engineering professions. Foremost amongst the early process developers were James Watt with the further development of the steam engine in 1764, Hargreaves and the 'spinning jenny', Cartwright's 'power loom' and Maudsley's 'screw cutting lathe'. These inventions gave the Industrial Revolution its initial impetus. This led to the increasingly widespread establishment of the 'factory system'. Adam Smith's 'The Wealth of Nations' (1776) proclaimed the benefits of the division and specialization of labour. Thus production activities came to be broken into small, specialized tasks assigned to workers through the manufacturing process, as opposed to the craftsman's 'make-complete' approach. Increased capital intensity through mechanization and new ways of planning and controlling production workers using the principles of specialization led to a move away from the cottage system to that of factory working.

Two notable developments occurred in the nineteenth century. First was the concept of *interchangeability*. One of the earliest attempts at production using interchangeable parts was successfully accomplished by Eli Whitney, a manufacturer of rifles for the US government, in 1790. Whitney designed and built on an assembly line such that parts were produced to tight tolerances enabling every part to fit right first time into a rifle assembly. Previously parts were hand crafted, or else they were merely sorted from large batches to find those components that fitted together neatly or only required minor modifications. The concept of interchangeable parts was not easily grasped at first, but is today taken for granted. Consider where we would be without interchangeable light bulbs to holders and interchangeable discs for CD and DVD players.

By 1850 the cottage system was almost completely replaced by factory working. Industrial empires were being constructed by a new class of entrepreneurs and businessmen. By 1900 the high level of capital and production capacity, the expanded urban workforce, new Western markets and increasingly effective transportation and communication set the stage for the great production output explosion of the twentieth century.

Around 1900 the Scientific Management approach was being developed. This was initially based upon the pioneering work of Frederick Winslow Taylor (1856–1915), outlined in his ‘Principles of Scientific Management’ (Taylor, 1911). At the time, scientific management represented a concerted attack on the prevailing techniques used in the management of production. The work of Taylor, Lilian and Frank Gilbreth and Henry Gantt, amongst others, was analytical and stressed the need for the development of standards for work and improved efficiency. There was little consideration, however, of human feelings and most practitioners of scientific management viewed operators as mere extensions of their machines working within a wider, controlled system.

A number of ideas and techniques were developed at this time including piecework payment systems, time and motion study, the principles of efficiency, standards and management by exception. Criticized as scientific management is today, and in many respects rightly so, its development constituted the first truly rigorous and structured theory of production management to replace the more general and less analytical methods of factory management used before. Scientific management principles culminated with the opening of the Ford Motor Company’s Rouge plant in Detroit for the production of the Model-T (see Womack *et al.*, 1991 for an interesting discussion of the rationale behind early Ford systems). The Rouge plant featured standardized product designs using interchangeable parts; mass production;

low manufacturing costs; mechanized assembly lines; and high specialization of labour. Ford was an adapter rather than an inventor of scientific management and the Rouge plant formed the model for factory design and work organization well into the twentieth century (the approach now commonly known as 'Fordism'). So, around the 1920s, was born the era of mass manufacture and standardized, low variety products.

In the 1930s an opposing view to scientific management began to emerge in which behavioural issues were identified as being important to productivity. Knowledge of psychological and sociological features started to influence job design, strategies for worker motivation and management control policies. The organizational forms of production and service companies have been influenced by a number of '*behaviouralist*' theories and practical approaches. A seminal programme of research were the *Hawthorne Studies*. These were a series of experiments conducted by researchers from the Harvard Business School at Western Electric Company which illustrated the importance of human aspects in determining output and productivity (Roethlisberger and Dickson, 1939). These were later followed by further theories of motivation (see, e.g., Maslow, 1943; McGregor, 1960; Likert, 1961; and Herzberg, 1966).

A major contribution to our understanding of operations management was made by the *sociotechnologists*. On the evidence of development of work design in the British coal mining industry, the teamwork approach to flowline assembly at Philips, Eindhoven, and the experiences of Volvo in Sweden with autonomous group working, theorists (most predominantly from the Tavistock Institute) stressed the need for the parallel development of social and technical systems for the success of manufacturing operations (see, for example, Gyllenhammar, 1977). More recently the need for flexible labour to cope with changes in the market and environment has been identified.

Atkinson's (1984) model of the 'Flexible Firm' was developed as an explanation of flexible organization. 'Post-Fordism' has developed whose supporters argue that the era of mass production is now over with more flexible and less rigid work structures now developing (Murray, 1989). The argument for 'Flexible Specialization' has been forwarded which sees a revival of craft-forms of production and the need for multi-skilling in the workforce (Piore and Sabel, 1984).

In terms of tools and techniques for operations management, we are indebted to the Operational Research (OR) School. OR originated in the military and defence organizations of Britain and the USA in the 1940s, during World War Two, to help solve problems of civilian defence, bombing strategies, transportation and military logistics. Subsequently OR theorists turned to business and industry to apply their techniques. The spin-offs for operations management included new quantitative techniques for stock control, scheduling, forecasting, project management, quality control, simulation and linear programming, to name just a few. In the 1950s OR was responsible for the introduction of computers in the management of operations. OR seeks to replace intuitive decision making for large complex problems with approaches that identify 'optimal' or 'best' solutions through analysis. It is in its logical and methodological approach that OR has contributed to the developing theory of operations management. (For more detail on the history and the techniques of OR see Duckworth *et al.*, 1977.)

Computers are now a highly cost effective and efficient means of managing and distributing the information required to plan and operate production and service systems. New computer technologies have also had a profound impact on the design of new processes with the development of flexible and programmable systems. Most significantly, the control afforded by computer technology has made possible the manufacture of

products in mass volumes, but in a wide variety and, in some instances, configured to suit individual customer requirements.

There has been a vast expansion in the service and public sector industries since 1960. During this time manufacturers and service operators have come to realize that they have a considerable amount to learn from one another and that there are innumerable areas of similarity in the management of their operations. Note also that all products will have an element of tangible good and service associated with them. Conversely many services also have a tangible product content (e.g. a MacDonald's burger is both a physical 'good', but also is associated with a 'package of service elements'). The need to manage service operations efficiently and effectively is just as necessary as the productive management of manufacturing, especially as many service operations have high visibility for the customer or client. Many principles and concepts are transferable. For example, all service operators will have inventories to manage, quality to control, work to schedule, output to deliver, facilities to layout, employees to remunerate, and so on. However the lessons are not one-way. Manufacturing organizations are learning much in terms of customer care and service reliability and flexibility from the service industries.

The economic expansion of Asia, and most notably Japan, since the 1960s has stimulated the development of alternative operations theory and practice. New concepts such as 'just-in-time' management, new approaches to quality and design management (such as Total Quality and Kaizen) and the encapsulation of these principles into 'lean operations' were evolved, in Japan particularly. This served warning of a new challenge to the traditional Western manufacturers (Hayes and Wheelwright, 1984; Schonberger, 1986; Womack *et al.*, 1990).

Another recent development has been the shift in emphasis from techniques and systems at the operating level to a broader and

more balanced strategic perspective of operations. The works of Wickham Skinner (1985) and Terry Hill (1985) in the area of strategic management and its interface with operations are germane here. As indicated earlier in this chapter, operations management is not merely confined to low level, limited impact decision making, but has a strategic consequence. Businesses that expect to remain competitive now need to grasp this, and ensure that product service and delivery live up to the claims made in advertising and promotion campaigns.

Referring back to Figure 1.5, it has been illustrated how the development of operations management has been closely tied with the emergence of a number of schools of thought over the last 200 to 300 years. In the 1800s the prime focus was the management of the factory, but as scientific management practices became more widespread in the early twentieth century the discipline changed from general factory management to production management. The wider operational perspective brought in by OR to encompass transportation, logistics and supply plus the growing need to incorporate and learn from service operations has broadened the discipline further. Now, subject to the influence of computer developments and Japanese approaches, the theory and practice of operations and quality management continues to develop under the influence of a number of different, and often conflicting, schools and paradigms.

Summary

This chapter has introduced the topic of operations management and has outlined the structure and logical presentation of the book. It has defined some core theory: five key performance indicators (KPIs) = quality, speed, dependability, flexibility and cost; four Vs = volume, variety, variation, visibility. It

has suggested ways of conceptualizing the scope of operations management by considering: the components of an operations system; the life cycle for products; the organizational scope of operations management. Finally, to better contextualize the topic, it provided a synopsis on the evolution of operations management.

Further reading

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- Smith, A. (1776, reprinted 1970) *The Wealth of Nations*, Everyman's Library, London.
- Taylor, F.W. (1911, reprinted 1967) *The Principles of Scientific Management*, Norton, New York,
- Van Looy, B., Gemmel, P. and Van Dierdonck, R.V. (eds) (2003) *Services Management: An Integrated Approach*, 2nd edn, Pearson Education Ltd.

Useful internet sites

- www.euroma-online.org European Operations Management Association (EUROMA).

- www.informs.org Institute for Operations Research.
- www.iomnet.org.uk Institute of Operations Management.
- www.manufacturinginstitute.co.uk The Manufacturing Institute.
- www.mas.berr.gov.uk Manufacturing Advisory Service. Department for Business Enterprise and Regulatory Reform (BERR) – for UK manufacturers.
- www.poms.org Production and Operations Management Society.

Useful academic journal articles

- www.emeraldinsight.com/ijopm.htm International Journal of Operations and Production Management (IJOPM).
- www.poms.org/journal Production and Operations Management (POM).
- www.sciencedirect.com/science/journal/02726963 Journal of Operations Management (JOM).

