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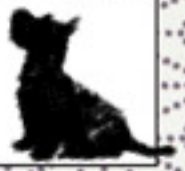

Operations Management

Andrew Greasley

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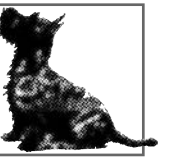

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SAGE Publications
Los Angeles ▪ London ▪ New Delhi ▪ Singapore

First published 2008

SAGE Publications Ltd
1 Oliver's Yard
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London EC1Y 1SP

SAGE Publications Inc.
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Thousand Oaks, California 91320

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B 1/I 1 Mohan Cooperative Industrial Area
Mathura Road, New Delhi 110 044
India

SAGE Publications Asia-Pacific Pte Ltd
33 Pekin Street #02-01
Far East Square
Singapore 048763

Library of Congress Control Number: 2006939578

British Library Cataloguing in Publication data

A catalogue record for this book is available from
the British Library

ISBN 978-1-4129-1882-4
ISBN 978-1-4129-1883-1 (pbk)

Typeset by C&M Digitals (P) Ltd, Chennai, India
Printed in Great Britain by The Cromwell Press, Trowbridge, Wiltshire
Printed on paper from sustainable resources

contents

part one
introducing your companion

This SAGE Course Companion offers you an insider's guide into how to make the most of your undergraduate course, and extend your understanding of key concepts covered in the course. It will provide you with essential help in revising for your course exams, preparing and writing course assessment materials, and enhancing and progressing your knowledge and thinking skills in line with course requirements. It isn't intended to replace your textbooks or lectures – it is intended to save you time when you are revising for your exams or preparing coursework. Note that RE-vision implies that you looked at the subject the first time round!

The Companion will help you to anticipate exam questions, and gives guidelines on what your examiners will be looking for. It should be seen as a framework in which to organise the subject matter, and to extract the most important points from your textbooks, lecture notes, and other learning materials on your course.

This book should direct you to the key issues (and key thinkers) in the operations management field. Whichever textbook you are using, the basics are the basics: we have given some guidance on where topics are covered in specific books, but you should read the Companion in parallel with your textbook and identify where subjects are covered in more detail in both your text and in your course syllabus.

There is also a study and revision skills guide in Part Three which will help you to learn more efficiently. Learning is best accomplished by seeing the information from several different angles – which is why you attend lectures and tutorials, read the textbook, and read around the subject in general. This book will help you to bring together these different sources.

How to use this book

This book should be used as a supplement to your textbook and lecture notes. You may want to glance through it quickly, reading it in parallel with your course syllabus and textbook, and note where each topic is

covered in both the syllabus and this Companion. Ideally, you should have already bought this book before your course starts, so that you can get a quick overview of each topic before you go into the lecture – but if you didn't do this, all is not lost. The Companion will still be equally helpful as a revision guide, and as a way of directing you to the key thinkers and writers on operations management.

The next part of this section provides an introduction to the subject area of operations management and its relevance to people in organisations. The next section goes into the curriculum in more detail, taking each topic and providing you with the key elements. Again, this does not substitute for the deeper coverage you will have had in your lectures and texts, but it does provide a quick revision guide, or a 'primer' to use before lectures.

You can use this book either to give yourself a head start before you start studying operations management, in other words give yourself a preview course, or it can be used as a revision aid, or of course both. Each section contains within it the following features:

- Tips on handling the infor mation in exams, or r eminders of key issues: these will help you to anticipate exam questions, and to r emember the main points to bring in when answering them.
- Examples: These ar e useful for putting the theor y into a 'r eal-world' context, and can of course be used in exams to illustrate the points you make.
- Running themes: the ar eas that will always be of inter est to an operations manager. You will find that these can almost always be br ought into an exam question, and you will be expected to do so.
- Input fr om key thinkers in the field: this will be useful to quote in exams, as well as pr oviding you with the main influences in the development of operations management.
- Sample exam questions with outline answers: these should help you be better pr epared for the actual questions, even though they will (of course) be different.
- Taking it Fur ther section: this is about taking your thinking a stage beyond simply laying out the cur rent 'r eceived wisdom'. The T aking it Fur ther section introduces some criticality , often fr om 'sharp end' academic thinking, and will help you to take a br oader conceptual view of the topic: on a practical level, this is the type of thinking that moves you fr om a pass to a first!

Part Three of this Companion is a study guide which will help you with getting more from your lectures, remembering more when you are sitting exams, and with writing essays.

At the back of the book you will find a glossary of the key terms that are used in the book and an index.

Introduction to operations management

Operations management is about the management of the processes that produce or deliver goods and services. Not every organisation will have a functional department called 'operations', but they will all undertake operations activities because every organisation produces goods and/or delivers services.

The operations manager will have responsibility for managing the resources involved in this process. Positions involved in operations have a variety of names, and may differ between the manufacturing and service sectors. Examples of job titles involved in manufacturing include logistics manager and industrial engineer. Examples in the service industry include operations control manager (scheduling flights for an airline), quality manager, hotel manager and retail manager.

People involved in operations participate in a wide variety of decision areas in an organisation, examples of which are given below:

• Service Operations Management	How do we ensure customers receive a prompt service?
• Operations Strategy	What strategy should be followed?
• Operations Performance Objectives	How do we measure the performance of our operations processes?
• Process Types	How do we configure the process which will deliver our service to customers?
• Layout Design	How do we organise the physical layout of our facilities and people?
• Long-term Capacity Planning	How do we ensure we have the correct amount of capacity available when needed?
• Facility Location	What should be the location of our operations facilities?
• Process Technologies	What role should technology have in the transformation of materials in the operations system?
• Designing Products and Services	What products and services should the organisation provide?
• Process Design	How do we design the service delivery process?
• Job Design	How do we motivate our employees?

• Planning and Control	How do we deploy our staff day-to-day?
• Capacity Management	How do we ensure that our service is reliably available to our customers?
• Inventory Management	How can we keep track of our inventory?
• Lean Operations and JIT	How do we implement lean operations?
• Enterprise Resource Planning	How do we organise the movement of goods across the supply chain?
• Supply Chain Management	What benefits could e-procurement bring to our operations?
• Project Management	How do we ensure our projects finish on time and within budget?
• Quality	How can we implement a TQM programme?
• Operations Improvement	How do we improve our operations performance over time?

The scale, importance and hopefully the excitement of operations management are indicated by the range of these decision areas. You will find that most texts on the subject area of operations management are structured around these decision areas, as are the 'Core areas of the curriculum' chapters in this text.

Operations management did not emerge as a formal field until the 1950s and 1960s when textbooks specifically dealing with operations management were published. Major developments up to this point impacting on the field of operations management start with the Industrial Revolution of the eighteenth century. Before this time products were made individually by skilled craftspeople in their homes and so were relatively expensive to produce. The use of inventions such as the steam engine (by James Watt in England, 1764) and concepts such as the use of interchangeable parts (Eli Whitney, 1790) and the division of labour (described by Adam Smith, 1776) led to the move to volume production. Here mechanisation (provided by steam power) was combined with the use of low-skilled labour (people were given small, simple tasks using the concept of the division of labour) to produce standard parts in high volumes which could be assembled into products. These ideas were

refined by the use of scientific management, developed by Frederick W. Taylor, who incorporated elements such as time study. The invention of the moving assembly line (first used by the car manufacturer Henry Ford in 1913) led to the era of mass production at the start of the twentieth century. This represented a major breakthrough in the ability of production systems to offer goods to a large number of customers at a price they could afford.

An additional element in the make-up of operations management occurred during the Second World War, when a need to solve the complex problems of logistics and weapons-system design led to the development of the area of operations research. A number of the techniques developed then are still part of the operations management field today. As stated earlier, operations management as a discipline then began to emerge in the 1960s and has continued to develop since.

The 1970s saw the use of computers in Materials Requirements Planning (MRP) software for inventory control and scheduling. The 1980s saw the emergence of the just-in-time (JIT) philosophy from Japan which transformed the way businesses deliver goods and services. In response to the need to improve the quality of goods and services, the ideas of Total Quality Management (TQM) were widely adopted in the 1980s. The 1990s saw the emergence of such concepts as supply chain management and Business Process Reengineering (BPR). Most recently, the use of the internet to conduct transactions or e-commerce has changed the way operations management is performed.

The history of operations shows how the field has adapted and continues to change as it tries to respond to an ever greater range of challenges, from the needs of customers who require high quality low price goods delivered quickly to managing the impacts of global competition and addressing environmental concerns.

part two

core areas of the curriculum

The content of operations management is relatively stable, covering the main areas of design (for example process types), management (for example JIT operations) and improvement (for example Total Quality Management). Some of the themes that have become prominent in the area of operations and which may be incorporated into your assignment and examination work are outlined below:

1 **The role of services in operations management:** although historically associated with the manufacturing industry, there has been a shift in the theory and practice of operations management to incorporate service systems. This is partly due to the importance of the service industry which accounts for an increasing proportion of the output of industrialised economies. Section 2.1 specifically covers service operations management.

2 **The strategic role of operations management:** despite the term 'operations', operations management is not simply about the day-to-day (that is, operational) running of an organisation. Operations management does in fact have an important strategic role in ensuring that the management of an organisation's resources and processes moves that organisation closer to its long-term goals. Section 2.2 specifically covers operations strategy.

3 **The role of technology in operations management:** technology plays a key role in the transformation process which operations is responsible for. Process technology is used to help transform the three main categories of transformed resources which are materials, customers and information. Section 2.8 specifically covers operations technology.

As stated previously, you will find that the area of study in operations management is quite standardised across different textbooks and curricula. However, because of the wide-ranging nature of the area you will probably only cover a subset of the topics examined in this section. The main aspect of the approach to the subject which you

may find is that different academics will devise curricula with varying amounts of quantitative elements. Thus while there is a general move towards a qualitative approach adopted in textbooks, and in this revision guide, you may find you need to revise quantitative elements of the topic such as network analysis, inventory models and linear programming. A good way of getting a feel for the assessment is to try to obtain past assignments or exam papers. Make sure you check that the curricula and academic have not changed, however, or you could be in for a surprise!

Each section below gives a quick overview of the key issues in the topic with sample exam questions and outline answers. You will most likely need to expand on these outlines in your exam responses. Remember, if indicative marks are provided for exam questions then use them as a guide to the amount of time you spend on your answers.

2.1 service operations management

Although historically associated with the manufacturing industry, there has been a shift in the theory and practice of operations management to incorporate service systems. This is partly due to the importance of the service industry which accounts for an increasing proportion of the output of industrialised economies. There is some disagreement about what constitutes the service sector, but in the widest sense it can be seen as organisations that do not fall into what the economists call the 'primary sector' (farming, forestry and fishing) or 'secondary sector' (industries including manufacturing, mining and construction). The rise to prominence of the service sector in the economies of developed countries is due to an increase in what are termed 'consumer services' and 'producer services'.

Consumer services are services aimed at the final consumers and these have risen in line with people's increasing disposable income in developed countries. Once expenditure on essentials such as food and shelter have been accounted for, people will then spend on purchases such as travel, hotels, restaurants and other social and personal services.

Producer services are used in the production and delivery of goods and services and constitute firms providing services such as consultancy advice, legal advice, IT support, transportation and maintenance facilities. The rise of producer services indicates that although the share of manufacturing is declining, it still plays an important part in a nation's economy. This is because many of the producer services are actually in business to provide services to manufacturers. Also many of these services that are being provided were once undertaken by manufacturers themselves and were thus classified as part of the manufacturing sector!

Types of service operations

In order to assess the challenges for operations in managing services it is useful to determine the characteristics of different services. You will find that textbooks differ in how they categorise services. One classification is that services themselves can be classified by their tangibility, while the way they are delivered can be classified by their simultaneity.

Tangibility

This is the most commonly used distinction between goods and services. Goods are tangible, they are a physical thing you can touch. A service is intangible and can be seen as a process that is activated on demand. In reality, however, both goods and services have both tangible and intangible elements and can be placed on a continuum ranging from low to high intangibility.

If goods are tangible, they are a physical thing you can touch. A service is intangible and can be seen as a process that is activated on demand.

Simultaneity

Simultaneity relates to the characteristic that services are produced and consumed simultaneously. This means the service provider and

customer will interact during the service delivery process. The amount of interaction is termed the 'degree of customer contact'. In fact the customer is unlikely to be a passive receiver of the service, but will be involved to a greater or lesser extent in the actual delivery of the service itself. For instance, a supermarket requires the customer to choose and transport the goods around the store and queue at an appropriate checkout till. However, it should not be assumed that all employees in a service operation have to deal directly with a customer. For the supermarket, the checkout till is an example of high customer contact, but store personnel may not have to deal directly with the customer at all. This distinction in services is denoted by 'back office' tasks which add value to the inputs of the service operation (for example stocktaking) and 'front office' tasks which deal with the customer both as an input and output of the operation.

Simultaneity relates to the characteristic that services are produced and consumed at the same time.

The fact that services require simultaneity, and are produced and consumed simultaneously, implies another important characteristic of heterogeneity. This refers to the interaction of the customer, the service provider and the surroundings causing variability in the performance of the service. From the perspective of the service provider, humans by their nature are likely to vary their actions and sometimes make mistakes. Also individual customers will perceive the quality of the service differently and the context of the service encounter (for example the existence of queues or weather conditions) may also impact on the service. This variability in performance and perceptions may lead to difficulties in maintaining a consistent level of service quality.

Heterogeneity refers to the interaction of the customer, the service provider and the surroundings causing variability in the performance of the service.

Taking it FURTHER

Most operations systems produce a mixture of goods and services. Most goods have some supporting service element (for example a maintenance contract with a new washing machine), called a 'facilitating service', while many services will have supporting goods (for example a report provided by a management consultant), termed a 'facilitating good'.

"What are the implications of moving tasks between the front office and back office areas of a service operation?"

In order to answer this question you will need to provide a short definition of the terms 'front office' and 'back office'. For example you could say that 'back office' tasks add value to the inputs of the service operation (for example stocktaking) and 'front office' tasks deal with the customer both as an input and output of the operation. You could also note that different organisations will have a different balance between front and back office operations. In terms of moving tasks from back office to front office some traditional back office-focused organisations, such as manufacturers, are increasing the role of service experience and thus their front office operations. This is because they judge that the ability to differentiate on the service aspect of their offering may provide a longer-term source of competitive advantage than they can achieve by differentiating with the goods themselves. In terms of moving from front office to back office, some organisations are recognising that customer value is being added by the tangible aspect of the service package delivered by the back office operations. For example, budget airlines have eliminated many front-line service aspects of the flight experience and focus on the 'transportation of customer' process itself.

"Explain the term 'heterogeneity' as applied to the service operations."

This question requires you to provide a definition of the term 'heterogeneity' and a discussion of its use in an operations context. You could define heterogeneity as the interaction of the customer, the service provider and the surroundings causing variability in the performance of the service. From the perspective of the

service provider humans by their nature are likely to vary their actions and sometimes make mistakes. Also individual customers will perceive the quality of the service differently and the context of the service encounter (for example the existence of queues or weather conditions) may also impact on the service. From an operations perspective you can say that this variability in performance and perceptions may lead to difficulties for the operations manager in maintaining a consistent level of service quality. Some services, termed 'mass services', which operate at high volume and low variety of outcome, attempt to reduce variability due to heterogeneity by standardising the service. This can be achieved by using such approaches as training staff to follow standard procedures and using equipment to support the service delivery process. This approach may not however be appropriate for professional services, which operate at low volume and high variety because here the customer requires high levels of contact with the service provider and a customised service.

Textbook guide

GREASLEY: Chapter 1.
HILL: Chapter 5.
SLACK, CHAMBERS AND JOHNSTON: Chapter 1.

2.2 operations strategy

Operations management includes all the activities that are required to create or deliver a product or service. Operations engages the majority of the people employed and assets deployed in most organisations. Thus the way operations is managed in the long-term, the operations strategy, is likely to be a vital element of an organisation's success.

Two generic approaches to operations strategy are the market-based and resource-based approaches. Using a market-based approach an organisation makes a decision regarding the markets and the customers

within those markets that it intends to target. Along with meeting customer needs within a market the position the organisation takes in that market will in part depend on the actions of its competitors. Thus the organisation's market position is one in which its performance enables it to attract customers to its products or services in a more successful manner than its competitors.

A resource-based view of operations strategy works from the inside-out of a firm, rather than the outside-in perspective of the market-based approach. Here an assessment of operations resources and processes leads to a view of operations capability.

Taking it **FURTHER**

It has been found that not all companies pursue strategy in accordance with a purely market-based approach and it has been noted that competitiveness is not just a matter of simply improving performance along specific competitive dimensions, but incorporates the development of capabilities that provide specific operating advantages. Thus the resource-based view of strategy is that operations takes a more active role in providing long-term competitive advantage.

Operations strategy formulation

Input from Key Thinkers – Terry Hill

One of the most popular approaches to operations strategy formulation is termed 'the Hill methodology' (developed by Terry Hill at London Business School). The emphasis within the Hill methodology is that strategic decisions cannot be made based on information regarding customer and marketing opportunities addressed solely from a marketing function's perspective, but the operations capability must also be taken into account. Hill proposes that the issue of the degree of 'fit' between the proposed marketing strategy and the operation's ability to support it is resolved at the business level in terms of meeting corporate (that is, strategic) objectives.

There are a variety of ways in which operations strategy formulation is approached in textbooks. Hill provides an iterative framework that links together the corporate objectives: which supply the organisational direction and marketing strategy; which define how the organisation will compete in its chosen markets, and the operations strategy; which provide capability to compete in those markets. The framework consists of five steps:

1 Define corporate objectives.

2 Determine marketing strategies to meet these objectives.

3 Assess how different products win orders against competitors.

4 Establish the most appropriate mode to deliver these sets of products.

5 Provide the infrastructure required to support operations.

In traditional strategy formulation the outcome of Step 3 is 'passed on' to Steps 4 and 5 and no further feedback occurs between steps in the process. The Hill methodology requires iteration between all five steps in order to link operations capability into decisions at a corporate level.

Step 3 is the crucial stage in Hill's methodology where any mismatches between the requirements of the organisation's strategy and the operations capability are revealed. This step provides the link between corporate marketing proposals and the operations processes and infrastructure necessary to support them. This is achieved by translating the marketing strategy into a range of competitive factors (for example price, quality, delivery speed) on which the product or service wins orders. These external competitive factors provide the most important indicator as to the relative importance of the internal operations performance objectives discussed in Section 2.3 of this book.

Hill distinguishes between the following types of competitive factors which relate to securing customer orders in the marketplace:

- Order-winning factors: these are factors which contribute to winning business from customers. They are key reasons for customers purchasing the goods or services and raising the performance of the order-winning factor may secure more business.

- Qualifying factors: these are factors which are required in order to be considered for business from customers. Performance of qualifying factors must be at a certain level to gain business from customers, but performance above this level will not necessarily gain further competitive advantage.

From the descriptions above it can be seen that it is therefore essential to meet both qualifying and order-winning criteria in order to be considered and then win customer orders.

Step 3 of Hill's methodology involves providing a 'fit' between the external competitive factors derived from the market position and the internal performance objectives derived from the operations processes and resources (infrastructure). Some of the concepts underlining the idea of how this fit can be achieved are discussed below in terms of the concepts of trade-offs, focus and agile operations.

Trade-offs

The original idea of trade-offs is that there is a trade-off relationship between competitive objectives, such as cost, quality, delivery and so on that means to excel in only one objective usually means poor performance in some or all of the others. Thus an attempt to be good at everything will lead to being mediocre at everything.

There are two basic approaches to managing trade-offs. The first approach is to manage the trade-off factors within the constraints of the operations system. This involves ensuring that an operation's relative achievement in each dimension of performance should be driven by the requirements of the market. The second approach is to follow an improvement approach and loosen the constraints on the operations system. This involves improving the capability of operations to enable improvement in both dimensions of performance or improvement in one dimension while preventing or limiting any deterioration in the other.

Focus

The concept of focus is to align particular market demands with individual facilities to reduce the level of complexity generated when attempting to service a number of different market segments from an individual organisation. This is because it is difficult and probably inadvisable for operations to try to offer superior performance over competitors across all of the performance objectives (see Section 2.3).

The idea of focus has been used by many firms to break up large and complex organisations into more simple and focused operations. Although many managers argue that the break-up of organisations leads to higher costs in terms of duplication of equipment, floor-space and overheads, many companies have found that focusing has led to a decrease in operating and overhead costs.

> Input from Key Thinkers – Wickham Skinner
>
> Focused operations was first described by Wickham Skinner in 1974. Based on empirical research, Skinner claimed that a factory that focuses on a narrow product mix for a particular market niche will outperform a conventional plant which attempts a broader mission.

Agile operations

The aim of agile operations is to be able to respond quickly to changing market demand in order to retain current markets and gain a new market share. Agile operations aims to serve fast changing markets in which customers demand both high quality service and low cost. Thus an agile operations strategy aims to overcome trade-offs by developing the capability of its resources.

"Discuss the main types of flexibility."

Start your answer to this question with a definition of flexibility and then explain the types of flexibility that are relevant to the operations manager. Thus flexibility can be defined as the ability by an organisation to change what it does quickly. This can mean the ability to offer a wide variety of products or services to the customer and to be able to change these products or services quickly. Flexibility is needed so the organisation can adapt to changing customer needs in terms of product range and varying demand and can cope with capacity shortfalls due to equipment breakdown or component shortage. The following types of flexibility can be identified:

- *product or service*: to be able to quickly act in response to changing customer needs with new product or service designs.
- *mix*: to be able to provide a wide range of products or services.

- *volume*: to be able to decr ease or incr ease output in r esponse to changes in demand. V olume flexibility may be needed for seasonal changes in demand. Ser vices may have to r eact to demand changes minute by minute.
- *delivery*: this is the ability to r eact to changes in the timing of a deliver y. This may involve the ability to change deliver y priorities between or ders and still deliver on time.

Flexibility can be measured in terms of range (the amount of the change) and response (the speed of the change). The range and response dimensions are connected in the sense that the more something is changed (range) the longer it will take (response). The relationship between the two can be observed by constructing range-response curves. In general the benefit of flexibility from the customer's point of view is that it speeds up response by being able to adapt to customer needs. The ability of the internal operation to react to changes will also help maintain dependability (see Section 2.3).

"Explain the significance for management of linking operations strategy, marketing strategy and corporate objectives."

The key to answering this question is to grasp that the question is asking you to pr o-vide an explanation for Hill's methodology for operations strategy . So explain that the emphasis within the Hill methodology is that strategic decisions cannot be made based on infor mation r egarding customer and marketing oppor tunities addr essed solely fr om a marketing function's perspective, but the operations capability must also be taken into account. Hill pr oposes that the issue of the degr ee of 'fit' between the pr oposed marketing strategy and the operation's ability to suppor t it is r esolved at the business level in ter ms of meeting corporate (that is, strategic) objectives. Thus Hill pr ovides an iterative framework that links together the corporate objectives; which supply the or ganisational dir ection and marketing strategy; which define how the or ganisation will compete in its chosen markets, and the operations strategy; which pr ovide capability to compete in those markets.

Textbook guide

GREASLEY: Chapter 2.
HILL: Chapter 2.
SLACK, CHAMBERS AND JOHNSTON: Chapters 2, 3.

2.3 operations performance objectives

In order to ensure that resources are allocated appropriately in operations it is necessary to record, monitor and review aspects of operations performance. A key task in this process is the identification of appropriate measures of performance that relate to the internal and external factors that are relevant to organisational competitiveness.

Slack et al. (2007) describe five basic operations performance objectives which allow the organisation to measure its operations performance. The performance objectives are quality, speed, dependability, flexibility and cost. Each one of these objectives will be discussed in terms of how they are measured and their significance to organisational competitiveness.

Quality

From a customer perspective quality characteristics include reliability, performance and aesthetics. From an operations viewpoint quality is related to how closely the product or service meets the specification required by the design, termed the 'quality of conformance'. The advantages of good quality on competitiveness include:

- Increased dependability: less pr oblems due to poor quality mean a mor e reliable deliver y pr ocess.
- Reduced costs: if things ar e done right first time expenditur e is saved on scrap and cor recting mistakes.
- Improved customer ser vice: a consistently high-quality pr oduct or ser vice will lead to high customer satisfaction.

Speed

Speed is the time delay between a customer request for a product or service and the receiving of that product or service. Although the use of a make-to-stock system may reduce the delivery time as seen by the

customer, it cannot be used for services and has disadvantages associated with producing for future demand in manufacturing. These include the risk of the products becoming obsolete, inaccurate forecasting of demand leading to stock-out or unwanted stock, the cost of any stock in terms of working capital and the decreased ability to react quickly to changes in customer requirements.

Thus the advantage of speed is that it can be used to reduce both costs (by eliminating the costs associated with make-to-stock systems) and delivery time, leading to better customer service.

Dependability

Dependability refers to consistently meeting a promised delivery time for a product or service to a customer. Thus an increase in delivery speed may not lead to customer satisfaction if it is not produced in a consistent manner.

Dependability can be measured by the percentage of customers that receive a product or service within the delivery time promised. Dependability leads to better customer service when the customer can trust that the product or service will be delivered when expected.

Dependability can also lead to lower cost, in that progress checking and other activities designed to ensure things happen on time can be reduced within the organisation.

In some instances it may even be important to deliver not too quickly, but only at the time required (for example a consignment of wet concrete for construction!).

Flexibility

Flexibility is the ability of an organisation to change what it does quickly. This can mean the ability to offer a wide variety of products or services to the customer and to be able to change these products or services quickly. Flexibility is needed so the organisation can adapt to changing customer needs in terms of product range and varying demand and can cope with capacity shortfalls due to equipment breakdown or component shortage. The following types of flexibility can be identified:

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Cost

Cost is considered to be the finance required to obtain the inputs (that is, transforming and transformed resources) and manage the transformation process which produces finished goods and services.

The major categories of cost are staff, facilities (including overheads) and materials. The proportion of these costs will differ between operations but averages are staff 15%, facilities 30% and materials 55%. Thus it can be seen that the greatest scope for reducing cost lies with a reduction in the cost of materials. A relatively small proportion of costs is usually assigned to direct labour.

If an organisation is competing on price then it is essential that it keeps its cost base lower than that of the competition. Then it will either make more profit than its rivals, if the price is equal, or gain market share if the price is lower. Cost is also important for a strategy of providing a product or service to a market niche, which competitors cannot provide. Thus cost proximity (namely to ensure costs are close to the market average) is important to maximise profits and deter competitors from entering the market.

Taking it FURTHER

We can categorise the benefits of excelling at the performance objectives from an internal and external perspective. This is useful because even though a performance objective may have little relevance in achieving the performance that external stakeholders, such as customers, value it may bring benefits in improving the capability of operations from an internal perspective.

Strategies that rely on immediate cost cutting (and thus risk damage to the operations capability) can be replaced by strategies that aim to improve performance on the other performance objectives which will then lead to a reduction in cost. It has been suggested that an improvement strategy should tackle the performance objectives in the order of quality, dependability, speed, flexibility and finally cost.

"How can the relative significance of the five performance objectives be determined in formulating an organisation's strategic direction?"

This question r elates to Step 3 of the Hill methodology cover ed in Section 2.2. In Section 2.2 we saw that using the Hill methodology the marketing strategy is translated into a range of competitive factors (for example price, quality , deliver y speed) on which the pr oduct or ser vice wins or ders. These exter nal competitive factors pr ovide the most impor tant indicator as to the r elative impor tance of the internal operations per formance objectives. Fur thermore, Hill distinguishes between two types of competitive factors which r elate to securing customer orders in the marketplace. Or der-winning factors ar e factors which contribute to winning business fr om customers. They ar e key reasons why customers pur chase the goods or ser vices and raising the per formance of the or der-winning factor may secur e mor e business. Qualifying factors ar e factors which ar e r equired in order to be consider ed for business fr om customers. The per formance of qualifying factors must be at a cer tain level to gain business fr om customers, but performance above this level will not necessarily gain fur ther competitive advantage. From the descriptions above it can be seen that it is ther efore essential to meet both qualifying and or der-winning criteria in or der to be consider ed and then win customer or ders.

You could of course present a different model in your answer (or maybe both if you had time and the indicative marks made it worthwhile). One alternative to the order-winning and qualifying competitive factors used by Hill is a model by Slack that uses two dimensions – importance and performance – to help operations managers prioritise performance objectives. The relative importance of a competitive factor is assessed in terms of its importance to internal or external customers using a 9-point scale of degrees of order-winning, qualifying and less important customer-viewed competitive factors.

Textbook guide

GREASLEY: Chapter 2.
HILL: Chapter 16.
SLACK, CHAMBERS AND JOHNSTON: Chapter 2.

2.4 operations process types

In operations the design of the process is categorised into types for manufacturing and services. The choice of process design is most dependent on the volume and variety of the product or service that an organisation offers.

Generally manufacturing and services providers serve their customers on a continuum between a combination of low variety and high volume products and services to a combination of high variety and low volume products and services.

Manufacturing process types

In manufacturing, process types can be considered under five categories of project, jobbing, batch, mass and continuous. A description of each

process type is followed by some examples of where each process type might be used.

Project

A project process is used to make a one-off product to a customer specification. A feature of a project process is that the location of the product is stationary. Examples of the use of a project process include building construction, movie film production, custom-built furniture.

Jobbing

Jobbing processes are used to make a one-off, or low volume, product to a customer specification. The product moves to the location of transforming resources such as equipment. Examples of the use of a jobbing process include bespoke tailors and precision engineers.

Batch

Batch processes cover a relatively wide range of volume and variety combinations. Products are grouped into batches whose batch size can range from two to 100s. Examples of the use of a batch process include vehicle component assembly and clothing manufacture.

Mass

A mass or line process produces products of high volume and low variety. The process of production will essentially be the same for all the products and so it is cost effective to use specialised labour and equipment. Examples of the use of a mass process include vehicle manufacturing and assembly of consumer durables such as televisions.

Continuous

A continuous process operates continually to produce a very high volume of a standard product. The products produced by a continuous operation are usually as a continuous flow, rather than in discrete items,

such as oil and gas. Examples of a continuous process include oil refining, electricity production and steel making.

Service process types

The classification of service process types is more recent and less standardised than with manufacturing process types outlined above and so differs between textbooks. The classification used here is of three service process types – professional service, service shop and mass service – which are categorised in terms of their ability to cope with different volume and variety characteristics.

Companies may also use a combination of process types, for example jobbing and batch, for different product lines within a manufacturing plant. In services there may also be a mix of process types, with front-office customer-facing activities undertaken as a professional service, whilst back-office operations are organised as a service shop.

Professional service

Professional service is characterised by high levels of customisation, in that each service delivery will be tailored to meet individual customer needs. Professional service is also characterised by high levels of customer contact and a relatively high proportion of staff supplying the service in relation to customers. Examples of professional service include management consultancy, doctors and health and safety inspectors.

Service shop

Service shop processes operate with a medium amount of variety and volume. There will be therefore a mix of staff and equipment used to deliver the service. Examples of service shops include banks, shops, restaurants and travel agencies.

Mass service

Mass service processes operate with low variety and high volume. There will be little customisation of the service to individual customer needs

and limited contact between the customer and people providing the service. Examples of mass service providers are supermarkets, rail services and airports.

Input from Key Thinkers – Christopher H. Lovelock

Lovelock offers an alternative service process type classification based on the degree of labour intensity against the degree of interaction and customisation. In this model labour intensity refers to the ratio of labour cost incurred in relation to the value of plant and equipment used to deliver the service. The degree of interaction and customisation refers to a joint measure of the degree to which the customer interacts with the service process and the degree to which the service is customised. The interaction and customisation variables are seen as generally showing similar behaviour, namely if interaction is high, so too is customisation. Lovelock feels this joint measure is an improvement on the sole use of customer contact as a variable as he states that the nature of the service also depends on the irregularity and thus the need for customisation in the service provision. An example is given of a hotel and hospital. Both services are classified as high customer contact, but the irregularity and complexity of the service provision in a hospital make the nature of its service provision different.

There are four categories of service type in Lovelock's model. Professional services are defined as having a high degree of both variables, whilst a service factory has low labour intensity and low interaction and customisation. Mass service is defined as high labour intensity and low interaction and a fourth category of service shop is defined as high labour intensity and low interaction.

Choosing a process type

The difficulty of the procedure of process type choice is that process decisions can take a relatively large amount of time and money to implement whereas market needs in a competitive environment can change rapidly. The choice of process type for a process may also change over time. This may occur either at the level of the organisation or at an individual product or service level.

At the level of the organisation the company may be following a growth strategy, which involves standardisation of its product or services or a strategy for increasing the range of products and services to avoid competing on price alone. At the level of the individual product or service there may be a repositioning of that product or service in the marketplace at a new volume/variety mix.

Also within the portfolio of products and services that an organisation delivers, an individual product or service will progress through a lifecycle, in terms of sales from introduction to maturity to decline. The process that best suits the needs of the firm will need to change to match the volume and variety of the output.

Input from Key Thinkers – Robert Hayes and Steven Wheelwright

For a certain volume and variety combination an organisation needs to make a choice regarding which process type to use. Hayes and Wheelwright have developed a widely used model that describes this choice in terms of a trade-off between cost and flexibility.

"What are the characteristics of the main process types in manufacturing and provide examples of where they are used?"

An alter native to this question is to ask for the main characteristics of the pr ocess types in ser vices, so be car eful to make sur e you ar e giving ser vice or manufacturing examples as appr opriate! If the question simply asks for characteristics of main process types, then you can cover both manufacturing and ser vice in your answer . In this case you ar e required to pr ovide a shor t definition of each manufacturing pr ocess type and then, impor tantly, examples of use. An abbr eviated answer is given below .

The main manufacturing pr ocess types ar e pr oject, jobbing, batch, line and continuous. Pr oject pr ocesses pr oduce pr oducts of high variety and low volume. A featur e of a pr oject pr ocess is that the location of the pr oduct is stationar y. Examples of the use of a pr oject pr ocess include constr uction, movie film pr oduction, custom-built fur niture. Jobbing pr ocesses pr oduce pr oducts of high variety and low volume. Jobbing pr ocesses ar e used to make a one-of f (or low volume) pr oduct to a customer specification. Examples of the use of a jobbing process include bespoke tailors and pr ecision engineers. Pr ocesses pr oducing products of medium variety and medium volume ar e ter med 'batch'. Examples of

the use of a batch process include vehicle component assembly and clothing manufacture. Line processes produce products of high volume and low variety. Examples of the use of a line process include vehicle manufacturing and assembly of consumer durables such as televisions. Continuous processes operate continually to produce a very high volume of a standard product. Examples of a continuous process include oil refining, electricity production and steel making.

Textbook guide

GREASLEY: Chapter 3.
HILL: Chapter 5 (services), Chapter 6 (manufacturing).
SLACK, CHAMBERS AND JOHNSTON: Chapter 4.

2.5 layout design

Layout design concerns the physical placement of resources such as equipment and storage facilities. The layout is designed to facilitate the efficient flow of customers or materials through the manufacturing or service system.

Layout design is important because it can have a significant effect on the cost and efficiency of an operation and can entail substantial investment in time and money. In many operations the installation of a new layout, or redesign of an existing layout, can be difficult to alter once implemented due to the significant investment required on items such as equipment.

There are four basic layout types of fixed position, process, cell and product layout.

Fixed-position layout

This layout design is used when the product or service cannot be moved and so the transforming process must take place at the location of product

creation or service delivery. In a fixed-position layout all resources for producing the product, such as equipment and labour, must move to the site of the product or service. The emphasis when using a fixed-position layout is on the scheduling and coordination of resources to ensure that they are available in the required amounts at the required time. Process types associated with a fixed-position layout are project process type in manufacturing and professional service type in services. Examples of fixed-position layouts include construction sites such as for buildings or for large ships, aircraft manufacture and full-service restaurants.

Process layout

A process layout, also termed a 'functional layout', is one in which resources (such as equipment and people) which have similar processes or functions are grouped together. Process layouts are used when there is a large variety in the products or services being delivered and it may not be feasible to dedicate facilities to each individual product or service. A process layout allows the products or customers to move to each group of resources in turn, based on their individual requirements. Process types associated with a process layout are jobbing and batch process types in manufacturing and service shops in services. Examples of process layouts include supermarkets, hospitals, department stores and component manufacturers.

Because of their flexibility process layouts are widely used. One advantage is that in service systems they allow a wide variety of routes that may be chosen by customers depending on their needs. Another advantage is that the product or service range may be extended and as long as no new resources are required may be accommodated within the current layout.

Cell layout

A cell layout attempts to combine the efficiency of a product layout with the flexibility of a process layout. Cells are created from placing together resources which service a subset of the total range of products or services. When grouping products or services together in this way the grouping is termed a 'family'. The process of grouping the products or services to create a family is termed 'group technology'.

Group technology has three aspects:

1 Grouping parts into families

Grouping parts or customers into families has the objective of reducing the changeover time between batches, allowing smaller batch sizes, and thus improving flexibility. Parts family formation is based on the idea of grouping parts or customers together according to factors such as processing similarity.

2 Grouping physical facilities into cells to reduce transportation time between processes

Physical facilities are grouped into cells with the intention of reducing material or customer movements. Whereas a process layout involves extensive movement of materials or customers between departments with common processes, a cell comprises all the facilities required to manufacture a family of components or deliver a service. Material and customer movement is therefore restricted to within the cell and throughput times are reduced. Cells can be U-shaped to allow workers to work at more than one process whilst minimising movement.

3 Creating groups of multi-skilled workers

Creating groups of multi-skilled workers enables increased autonomy and flexibility on the part of operators. This enables easier changeovers from one part to another and increases the job enrichment of members of the group. This in turn can improve motivation and have a beneficial effect on quality.

Process types associated with a cell layout are batch and mass process types in manufacturing and service shops and mass services in services. Examples of cell layouts include custom manufacture, a maternity unit in a hospital, a cafeteria with multiple serving areas. In services a cell layout could involve an insurance organisation organised by type of claim (for example car, home, travel).

Product layout

Product layouts, also termed 'line layouts', arrange the resources required for a product or service around the needs of that product or service.

In manufacturing applications such as assembly lines with a high volume of a standard product the products will move in a flow from one

processing station to the next. In contrast to the process layout in which products move to the resources, here the resources are arranged and dedicated to a particular product or service. The term 'product' layout refers to the arrangement of the resources around the product or service. In services the requirements of a specific group of customers are identified and resources are set up sequentially so the customers flow through the system, moving from one stage to another until the service is complete. Process types associated with a product layout are mass and continuous process types in manufacturing and mass services in services. Examples of product layouts include car assembly, self-service cafes and car valeting.

A key issue in product layouts is that the stages in the assembly line or flow line must be 'balanced'. This means that the time spent by components or customers should be approximately the same for each stage, otherwise queues will occur at the slowest stage.

Detailed layout design

Once the layout type has been chosen its detailed configuration must be designed to meet the needs of a particular implementation. In a fixed-position layout there will be a relatively low number of elements and there are no widely used techniques to help locate resources. The relative positioning of equipment and departments in a process layout can be analysed in terms of minimising transportation costs or distances using an activity matrix. A cell layout uses the concept of group technology to group resources into cells to process families of parts or customers. Production Flow Analysis (PFA) is a group technology technique that can be used to identify families of parts with similar processing requirements. A product layout consists of a number of processes arranged one after another in a 'line' to produce a standard product or service in a relatively high volume. The technique of line balancing is used to ensure that the output of each production stage is equal and maximum efficiency is attained.

"Evaluate the use of the cell layout type."

When a question asks you to evaluate, you need to do mor e than just describe a concept (although that is a star t!), you also need to pr ovide a critical assessment

of its use. This can be done thr ough examining the advantages and disadvantages o f the concept and pr oviding r eal-life examples of its use, for example. In ter ms of a cell layout you can say that they attempt to combine the ef ficiency of a pr oduct layout with the flexibility of a pr ocess layout. Cells ar e cr eated fr om placing together r esour ces which ser vice a subset of the total range of pr oducts or ser vices. Pr oducts or ser vices gr ouped together ar e ter med a 'family'. Cr eating cells with dedicated r esour ces can significantly r educe the time it takes for pr oducts and ser vices to pass thr ough the pr ocess by r educing queuing time. It also offers the oppor tunity for automation due to the close pr oximity of the pr ocess stages. Thus pr ocess technology can be used to r eplace a number of general purpose r esour ces with a single dedicated multi-functional system such as a Flexible Manufacturing System (see Section 2.8). The system can also impr ove motivation as workers can see and be involved in a number of pr ocess stages. A disadvantage of cell layouts can be extra expenditur e due to the extra r esour ces required in moving to a cell layout, the cost of moving r esour ces and the issue that cells can lower plant utilisation.

Textbook guide

GREASLEY: Chapter 4.
HILL: Chapter 7.
SLACK, CHAMBERS AND JOHNSTON: Chapter 7.

2.6 long-term capacity planning

The level at which management sets the level of capacity is a key determinant of the competitiveness of an organisation. This decision needs to be made within a long-term plan which provides a fit with the operations strategy of that organisation. Long-term capacity issues can be considered in terms of the volume of capacity required and the timing of when that capacity should be acquired.

Capacity volume

In determining the optimum capacity level for a facility the concept of economies of scale is considered. Economies of scale relate to the capital costs of building a new facility and the fixed costs of operating a facility. The capital costs of building a facility do not increase proportionally as its capacity increases, so for example a facility with twice the capacity of another facility will not have capital costs twice as high.

This may suggest that the use of a single large facility that supplies all capacity needs is the most appropriate strategy. However at a certain capacity level for a particular location, diseconomies of scale may set in. These may include the transportation costs incurred in supplying a large geographical area from a single location when the speed of delivery from a single location to the customer becomes too slow. Also the added complexity of a large organisation may cause communication and coordination problems.

When considering economies of scale benefits it is important to understand that the rationalisation of a number of facilities into a single large facility will achieve economies of scale only if the multiple facilities are doing the same type of work. Simply putting the work of a number of facilities doing different activities within one building is unlikely to achieve economy of scale benefits.

An alternative to obtaining capacity volume within the organisation is to develop subcontractor and supplier networks. Here long-term contractual arrangements are made with suppliers to supply goods and services which means less capacity is required by the subcontracting organisation. An advantage of this approach is that less capital is required for production and delivery facilities. There is also the flexibility to decrease capacity to meet falling market demand without incurring the costs of under-utilisation of resources or to increase capacity without the expense of additional resources. A disadvantage is the risk that subcontractors may not be able to meet changing capacity requirements. There is also a risk of the loss of skills inherent when outsourcing activities.

Taking it FURTHER

Traditionally, significant investment in process technology, such as automation, has only been justified for high-volume products where economies of scale provide a lowest average cost per unit. However, modern process technology, such as flexible manufacturing systems, provides flexibility and allows a range of products to be produced quickly and efficiently. Thus economies of scope are created by the ability to produce many products in one highly flexible production facility more cheaply than in separate facilities.

Capacity timing

Textbooks often describe three main approaches to ensuring the correct amount of capacity is available at the right time to meet future plans. These are lead capacity, match capacity and lag capacity.

Lead capacity

This option is used to obtain extra capacity at a level above forecasted demand and so maintain a capacity 'cushion' to try to ensure capacity is sufficient if demand increases above that forecasted. This has the advantage of helping to maintain high levels of customer service and provides a response to increases in customer demand, but has the disadvantage of the cost of maintaining the capacity cushion for all the different types of capacity (people, equipment, locations) required over time. An advantage of using a capacity cushion is that the cushion can be allocated to different products and services over time as the nature of demand fluctuates, although this is limited by specialisation of resource, for example only trained people can do certain tasks.

Match capacity

The second option is to simply obtain capacity to match forecasted demand. The advantage of this option is that it avoids the costs of a capacity cushion and the use of strategies such as outsourcing may be

used to quickly fill capacity shortfalls. The disadvantage is the problem outlined earlier in terms of loss of performance due to an inability to change capacity to match variability in demand.

Lag capacity

The third option is only to add capacity when extra demand is present which would utilise the additional resources. This has the advantage of ensuring a high utilisation of capacity acquired, but may mean customers are lost as they move to competitor products and services before the additional capacity has been acquired.

EXAMPLE

A number of companies have grown rapidly (for example Wal-Mart, easyJet) by continually adding new capacity and lowering costs in an attempt to freeze competitors out of the market. Retailing is an industry where quick expansion into geographical locations can freeze competitors out of those geographical locations that can only support a single retail outlet of a certain type. In some cases it may form part of the business strategy to build over-capacity to secure a locational presence or provide a higher level of performance of a performance objective such as delivery speed.

"Discuss the three main approaches for ensuring the correct amount of capacity is available at the right time to meet future plans."

This question requires you to know that the three main approaches are lead capacity, match capacity and lag capacity. You'll need to describe the meaning of each one in turn and then add a discussion reflecting on the relative methods of all three. The key point is that there is a trade-off between minimising the cost of allocating capacity and the cost of poor customer service. The operations manager will need to take into account the context of the decision when addressing this trade-off.

Textbook guide

GREASLEY: Chapter 5.
HILL (RESOURCE PLANNING): Chapter 8.
SLACK, CHAMBERS AND JOHNSTON: Chapter 6.

2.7 facility location

There are three main reasons why a location decision is required. The first reason is that a new business has been created and requires facilities in order to manufacture its product or service its customers. The second reason is that there is a decision to relocate an existing business due to factors such as the need for larger premises or to be nearer a customer base. The third reason is to expand into new premises as part of a growth strategy.

The location decision can be considered in terms of factors that vary in such a way as to influence cost as location varies (supply-side factors) and factors that vary in such a way as to influence customer service as location varies (demand-side factors). The location decision can be seen as a trade-off between these factors. In service organisations a need for customer contact may mean that demand-side influences will dominate, while in a manufacturing company labour and distribution costs may mean supply-side influences dominate.

Supply-side influences

Distribution costs

Distribution and transportation costs can be considerable, especially for a manufacturing organisation that deals in tangible products. The sheer volume of the raw material involved in an operation such as steel production means that a location decision will tend to favour areas near to

raw materials. A manufacturer and seller of custom-built furniture however will need to be near potential customers. For service companies such as supermarkets and restaurants the need to be in a market-oriented location means that the cost of transportation of goods may not be a major factor in the location decision. However, many service organisations require distribution of stock from warehouses whose location should be considered carefully. Distribution across country borders means that a whole series of additional costs and delays must be taken into account, including import duties and delays in moving freight between different transportation methods (for example air, rail, truck, sea). A site near to an airport or a rail link to an airport may be an important factor if delivery speed is important.

Labour costs

Labour costs have generally become less important as the proportion of direct labour cost in high volume manufacturing has fallen. What is becoming more important is the skills and flexibility of the labour force to adapt to new working methods and to engage in continuous improvement efforts. The wage rate of labour can be a factor in location decisions, especially when the service can be provided easily in alternative locations. Information technology companies involved in data entry can locate in alternative countries without the customer being aware.

Energy costs

Some manufacturing companies use large amounts of power to operate production processes. Thus energy costs and the availability of enough energy to meet forecast demand can be important factors in the location decision.

Site and construction costs

Both the cost of the land and the cost of purchasing materials and building a facility are directly related to the location decision. These costs should be considered together as relatively low cost land may require substantial preparation to make it suitable for building development.

Intangible factors

There are also a number of factors that are not financial but may have an effect on the location decision. These include the potential for objections to development on environmental grounds, local regulations regarding business developments and the necessary quality of life in the area needed to attract skilled employees.

Demand-side influences

Labour skills

The need for a pool of skilled labour is becoming increasingly important. However, it may be possible in some instances to use skilled labour from a remote location, for example the use of computer programmers in India by American software companies.

Location image

Retail outlets in particular will wish to locate in an area which 'fits' with the image they are trying to project. Often shopping districts will be associated with a particular type of retail outlet for example designer clothing.

Customer convenience

For many service organisations in particular, the location of the facility must be convenient for the potential customer. This can range from restaurants were customers may be prepared to travel a short distance, to hospitals were the speed of response is vital to the service. The physical link between customer and service provider can be in either direction. For example, household goods such as gas ovens and central heating boilers will be serviced by staff at the customer's home.

Location selection techniques

The location selection process consists of identifying a suitable region/country, identifying an appropriate area within that region and finally

comparing and selecting a suitable site from that area. Techniques for location selection include the following.

Weighted scoring

The procedure consists of determining a list of factors that are relevant to the location decision. Each factor is then given a weighting that indicates its relative importance compared to the other factors. Each location is then scored on each factor and this score is multiplied by the factor value. The alternative with the highest score is then chosen.

The centre of gravity method

This can be used to determine the location of a distribution centre by minimising distribution costs. The relative coordinates of the distribution points are placed on a map with the location of the distribution point at the centre of gravity of the coordinates.

Locational Cost-Volume analysis

Locational Cost-Volume analysis will indicate when a particular location is superior for a particular volume level by analysing the mix of fixed and variable costs. Some costs such as the costs of building the facility will be fixed, while others such as the level of demand will vary with the location. The relationship between both of these factors will vary for each location being considered.

Locational Cost-Volume analysis assumes that fixed costs are constant for the volume range when in fact step changes may occur in fixed cost expenditure to meet certain volume levels. Also variable costs are assumed to have a linear (straight-line) relationship with volume, when this may not be so. Some Cost-Volume models may incorporate a non-linear (curved) relationship. Another assumption is that output of the facility has also been aggregated into one product that may not reflect the complexity of how a mix of products affects costs over a range of volumes.

“Discuss the main supply-side and demand-side influences in the location decision.”

For this question it would be appr opriate to explain what the ter ms 'supply-side' and 'demand-side influences' on the location decision r efer to. Then it is necessar y to discuss what the supply-side and demand-side influences might be. For supply-side influences include in the discussion distribution costs, labour costs, energy costs, site and constr uction costs and intangible factors. For demand-side influences include location image and customer convenience.

Textbook guide

GREASLEY: Chapter 5.
HILL: Chapter 7.
SLACK, CHAMBERS AND JOHNSTON: Chapter 6.

2.8 process technologies

The objective of an operations system is to convert transformed resources from inputs into outputs in the form of goods and services. Transformed resources can be in the form of material, information and customers and this section will show the use of technology in the transformation of these resource categories.

Technology is an important aspect of operations as it has led to a large growth in productivity in both manufacturing where the emphasis is on technology for material and information transformation and services where the emphasis is on technology for information and customer transformations.

Process technology for materials

Computer Aided Design (CAD) is one of the most widespread process technologies, used in even relatively small firms. A CAD system allows the designer to create drawings on a computer screen to assist in the visual design of a product or service. The drawings can be viewed from any

angle and can be zoomed to allow inspection of a design in detail. Drawings are held in a database for future use and disseminated between designers and engineers across the company.

Computer Aided Process Planning (CAPP) extends CAD by transmitting a process plan of how parts will be manufactured to the machine tool, for example deciding on how individual pieces are to be cut from a sheet of metal. CAPP systems can also sequence parts through a number of process steps.

Computer Aided Engineering (CAE) takes the drawings in a CAD system and subjects the designs to simulated tests, for example the behaviour of an engineering design for elements of a bridge can be observed under various amounts of stress. This allows design options to be tested quickly and cheaply.

Computer Numerically Controlled Machines (CNC) are machine tools that can be controlled by computer.

Machining Centres (MC) are more complex technology and incorporate features such as the ability to carry tools that can be automatically changed, depending on the requirements of the operation being undertaken.

A *robot* is a programmable machine that can undertake tasks that may be dangerous, dirty or dull for people to carry out. A robot may have an arm and end effector that is used to pick, hold and place items. Robots can generally undertake tasks quicker and more consistently than humans.

Automated Material Handling Systems (AMH) are designed to improve efficiency in the movement, storage and retrieval of materials.

Types of systems include *automated guided vehicle (AGV)* systems that transport material on driverless vehicles to various locations in the plant.

Automated Storage and Retrieval Systems (AS/RS) handle the storage and retrieval of materials using computers to direct automatic loaders to pick and place items in a storage facility.

Flexible Manufacturing Cell Systems (FMC) integrate individual items of automation described above to form an automated manufacturing system that can consist of two or more CNC machining centres, a robot and a cell computer which coordinates the various operations in the cell. The robot can be used to handle the parts that are being processed and also to perform tool-changing operations. The tool is the element of the CNC machine, for example the drill bit, that is used to process the part. The robot, under the direction of the cell computer, can sense when a tool needs changing either for processing requirements or if the tool is worn and needs replacing.

Flexible Manufacturing Systems (FMS) extend the facilities of a FMC by incorporating automatic parts loading and unloading facilities and an automated guided vehicle system for parts movement.

Taking it FURTHER

Flexibility (the production of a range of products at low cost that can be delivered quickly to customers) is a key strategic aim for operations. In terms of manufacturing this translates into the ability to perform rapid low cost switching from one product line to another. A Flexible Manufacturing System (FMS) is designed to provide fast, low cost changes from one part to another, to lower direct labour costs due to automation and achieve consistent and better quality due to automated control. However, the FMS machines may have a limited ability to adapt to changes in the product specification, a substantial amount of pre-planning is necessary before a FMS can be operated and the systems are very expensive in terms of capital investment. Due to these factors Flexible Manufacturing Cells (FMC) are often used as an alternative due to their lower complexity and lower cost. FMS are most relevant to the production of items such as small batches of machined goods. Another option to achieve flexibility is to use the JIT philosophy of a flexible workforce and small, simple machines.

Computer-Integrated Manufacture (CIM) integrates the above technologies using a computer network and database system. Whereas a FMS system is generally concerned with automation directly related to the transformation process, CIM is an automation of the product and process design, planning and control and manufacture of the product. In a fully integrated system the areas of design, testing, fabrication, assembly, inspection and material handling are automated and integrated using technology. For example Computer Aided Manufacturing (CAM) extends the use of CAD by transmitting the design, held in the CAD system electronically, to computer-controlled machine tools. Systems that combine these two functions are often referred to as CADCAM. CADCAM systems represent a major tool for operations in linking the design and manufacturing processes.

Process technology for information

Most organisations use some form of computer-based technology to accumulate, organise and distribute information. Most computers are now connected together in some form of network.

A Local Area Network (LAN) is usually limited to a company occupying a single building or even several buildings across a large company site.

A small-scale network such as this allows people to share information, communicate via systems such as e-mail and share facilities such as printing and software applications. A Wide Area Network (WAN) may connect people across a city, country or between different countries. If the WAN enables communication across the whole company, it is referred to as the 'enterprise network' or 'enterprise-wide' network. To minimise the size of investment in wide area communications a company can use a Value-Added Network (VAN) which is a network rented out by a service provider.

In the 1960s the use of Electronic Data Interchange (EDI) became established. This allows the exchange of structured information, such as orders, invoices, delivery advice and payment instructions, over a network. This allows for example the automatic reordering and payment for stock from a supplier without human intervention.

E-business

E-business can be seen as the transformation of business processes through the use of internet technologies. E-business opportunities can be classified in terms of whether an organisation is using the internet to transact with consumers, called 'business-to-consumer' (B2C) or other businesses, called 'business-to-business' (B2B). Business-to-business transactions predominate over the internet, in terms of value if not frequency. This is explained by the fact that there are many more opportunities for B2B transactions than B2C, both between an organisation and its suppliers, together with intermediaries, and through distributors such as agents and wholesalers with customers. Additionally there is a higher level of access to the internet among businesses than among consumers, and a greater propensity to use it for purchasing.

The benefits of e-business for operations relate to areas such as supply chain integration, using B2B and B2C interactions, as well as the increased efficiency and effectiveness of internal business processes using employee-to-employee (E2E) interactions.

E-commerce

Electronic commerce (e-commerce) is often thought to refer simply to buying and selling using the internet: people immediately think of consumer retail purchases from companies such as Amazon. But,

e-commerce involves much more than electronically-mediated financial transactions between organisations and customers. Many commentators refer to e-commerce as *all* electronically-mediated transactions between an organisation and any third party it deals with. By this definition, non-financial transactions such as customer requests for further information would also be considered to be part of e-commerce. 'Buy-side e-commerce' refers to transactions to procure resources needed by an organisation from its suppliers. 'Sell-side e-commerce' refers to transactions involved with selling products to an organisation's customers.

M-business

M-business can be defined as the integration of internet and wireless communications technology. It is a result of mobile communications facilitated by broadband (high bandwidth) internet connections and wireless technology (for example mobile phones using radio waves). Mobile computing allows people choice in how they communicate by offering multiple devices, applications and tools from which to select and it permits people to control the time and frequency with which they obtain information.

Some of the applications for m-business include:

- procurement: the extension of e-pr ocurement applications to enable or ders to be taken using handheld devices (for example bar code r eaders).
- order fulfilment and deliver y management: deliver y infor mation is input using a tablet and the customer can track their or der immediately over the inter net.
- asset tracking: the monitoring of materials inter nally will extend to the monitoring of highly mobile geographically dispersed assets.
- ser vice management: ser vice r equests can be automatically dispatched to field personnel to ensur e timely r esponse and ef ficient scheduling.

Customer Relationship Management (CRM)

CRM covers the whole process by which relationships with customers are built and maintained. CRM systems are designed to integrate the range of information systems that contain information regarding the customer. These include applications such as customer details and preference databases, sales order processing applications and sales force automation. The idea is to acquire customers, retain customers and increase customer involvement with the organisation.

Process technology for customers

One distinguishing feature of services is that the customer is often present while the service is being delivered. In fact the contact between the customer and service provider is often the service itself, such as a visit to the dentist. In order to provide a consistent level of quality of service it is therefore important that the service providers are well trained and motivated.

One approach to improving service delivery is to encourage the participation of the customer in the service delivery process itself. Thus instead of passively waiting for a service the customer can be enabled by technology to avail themselves of the service at a time of their choosing and to make choices regarding that service.

From a service provider viewpoint this has the advantage of reducing staffing requirements and empowering customers by giving them a greater sense of control over the type of service they require.

"What is the relevance of process technology in service organisations?"

You need to be very careful with a question such as this that you address your answer specifically to the concept in the context of service operations (that is, not manufacturing). As you know most services in reality consist of a combination of services and goods, namely an intangible and tangible element. For example retail outlets are services in that they don't actually manufacture the products they sell, but they do sell tangible items which need to be distributed and presented to the customer. This means distribution will require process technology in terms of information systems for inventory control for example and process technology for customers such as debit card PIN entry.

"What are the potential advantages of Customer Relationship Management (CRM)?"

You'll need to explain what CRM is and then outline the advantages of the concept. The advantages of CRM include better response to customer queries as customer data is to hand; better delivery performance through tracking of customer orders; more effective marketing campaigns by using customer data to target customer segments more accurately; improved efficiencies through faster

access to data, automation of processes and improved data accuracy; and improved profitability by improved targeting of marketing, better service to customers leading to a higher customer base and customer retention.

Textbook guide

GREASLEY: Chapter 6.
HILL: Chapter 9.
SLACK, CHAMBERS AND JOHNSTON: Chapter 8.

2.9 designing products and services

Good design of products and services is an essential element in satisfying customer needs and therefore ensuring the long-term success of an organisation. The success of the design process is primarily dependent on the relationship between the marketing, design and operations functions of an organisation. These functions need to cooperate in order to identify customer needs and produce a cost effective and quality design that meets these needs.

Service design

In service design the overall set of expected benefits that the customer is buying is termed the 'service concept'. The service will usually consist of a combination of goods and services and is termed the 'service package'.

Input from Key Thinkers – James A. Fitzsimmons and Mona J. Fitzsimmons

Fitzsimmons and Fitzsimmons define the service package as a bundle of goods and services consisting of the following four features:

(Continued)

(Continued)

1 Supporting facility: the physical resources that must be in place before a service can be offered.
2 Facilitating goods: the material purchased or consumed by the buyer or items provided by the customer.
3 Explicit services: the benefits that are readily observable by the senses and consist of the essential or intrinsic features of the service.
4 Implicit services: psychological benefits that the customer may sense only vaguely or extrinsic features of the service.

The point is that the providers of the service may only focus on the delivery of the explicit service and neglect the other components of the service package. It is important to recognise the effect on the level of service that all the elements of the service package have.

The design process

The steps involved in the design process are as follows.

Idea generation

Ideas for new products and services can come from a variety of sources, including an organisation's research and development (R&D) department, suggestions from customers, market research data, salespeople, competitor actions or developments in new technology. The major source of new ideas or innovations will be dependent largely on an organisation's strategy.

Feasibility study

The marketing function will take the ideas created in the idea generation stage and form a series of alternative concepts on which a feasibility study is undertaken. The concept refers not only to the physical product or specification of the service that the person is buying, but also the overall set of expected benefits that a customer is receiving. For instance a restaurant

meal consists not only of the meal itself, but also the level of attention and the general surroundings. Thus the concept is referring to the combination of physical product and service, referred to as the 'package', which delivers a set of expected benefits to the customer. Once a concept has been formulated it must then be submitted to a market and economic and technical analysis in order to assess its feasibility.

Preliminary design

Design concepts that pass the feasibility stage enter preliminary design. The specification of the concept – what a product or service should do to satisfy customer needs – is translated into a technical specification of the components of the package (the product and service components that satisfy the customer needs defined in the concept) and the process by which the package is created.

Final design

The final design stage involves refining the preliminary design through the use of a prototype until a viable final design can be made. Computer Aided Design (CAD) and Simulation Modelling can be used at this stage to build a computer-based prototype and refine the product and process design. The final design will be assessed in three main areas: Functional Design, Form Design and Production Design.

Functional design is ensuring that the design meets the performance characteristics that are specified in the product concept. Two aspects of functional design are reliability and maintainability. Reliability is an important performance characteristic and measures the probability that a product or service will perform its intended function for a specified period of time under normal conditions of use. Maintainability considers the cost of servicing the product or service when it is in use. This may include such issues as the ability of the customer to maintain a product or the need for trained personnel to undertake maintenance or repair activities. Maintainability is connected to issues such as the cost of the product (it may be cheaper to throw away rather than to repair the product) and its reliability (very high reliability will reduce the importance of maintainability).

Maintainability can be improved by modular design to enable whole modules to be replaced rather than undertaking the lengthy investigation of faults. Maintenance schedules should also be specified to help prevent problems from occurring. An improved ability to perform under adverse conditions (termed the 'design robustness') will improve maintainability.

Form design refers to product aesthetics, such as the look, feel and sound if applicable. This is particularly important for consumer durables but even industrial appliances should at least project an image of quality. In services the design of the supporting facility, such as the room décor, lighting and music in a restaurant, provides an important element of the service design.

Production design involves ensuring that the design takes into consideration the ease and cost of manufacture of a product. Good design will take into consideration the present manufacturing capabilities in terms of the material supplies, equipment and personnel skills available. The cost of production can be reduced by the following methods: simplification (reducing the number of assemblies), standardisation (enabling the use of components for different products and modules) and modularisation (combining standardised building blocks in different ways to create a range of products).

Taking it **FURTHER**

Mass customisation is an attempt to combine high variety and high volume output in order to provide the customer with customised products at a relatively low price. The expansion of options available in motor vehicles (for example engine size, engine type, body style) is an example of this approach. The ability to combine high volume and high variety can be achieved by excelling at the flexibility performance objective (see Section 2.3) in order to provide high variety, without the costs usually involved in achieving this. One way of doing this is to incorporate the ideas related to design for manufacture of simplification, standardisation and modularisation at the design stage.

Improving design

A number of techniques have been developed in an attempt to improve the design process. Although they have greater applicability to product design than to service design, they do have some relevance to service design.

Concurrent design

Concurrent design, also known as simultaneous development, is when contributors to the stages of the design effort provide their expertise throughout the design process as a team. This contrasts with the traditional sequential design process when work is undertaken within functional departments. The problem with the traditional approach is the cost and time involved in bringing the product to market. In some business sectors (for example consumer electronics) shrinking product life cycles have meant that new products or improvements to existing products are required in an ever shorter time scale. Concurrent design reduces the time wasted when each stage in the design process waits for the previous stage to finish completely before it can commence. For example critical equipment, some of which may take an extended time to purchase and install, is identified and procured early in the design process in order to reduce the overall development time.

Design for Manufacture (DFM)

An important aspect of good design is that the product designed can be produced easily and at low cost. Design for Manufacture (DFM) is a concept which views product design as the first step in the manufacture of that product. DFM incorporates guidelines on such aspects as simplification, standardisation and modularisation but also techniques such as Failure Mode and Effect Analysis (FMEA) and Value Engineering (VE).

Failure Mode and Effect Analysis (FMEA) Failure Mode and Effect Analysis (FMEA) is a systematic approach to identifying the cause and effect of product failures. The approach involves the following:

- listing the function of the component par ts of the pr oduct
- defining the failur e modes (for example leakage, fatigue) for all par ts
- ranking the failur es in or der of likelihood and seriousness
- addressing each failur e in rank or der, making design changes when necessar y.

The idea of FMEA is to anticipate failures and deal with them at the design stage.

Value Engineering (VE) Value Engineering (VE) aims to eliminate unnecessary features and functions that do not contribute to the Value or performance of the product. It is derived from the idea of Value Analysis (VA) which was developed to improve the actual design, particularly taking into account the use of new technology.

Quality Functional Deployment (QFD)

Quality Functional Deployment is a structured process that translates the voice of the customer (what the customer needs) into technical design requirements (how these needs are met). It is particularly relevant to the concept of concurrent design as it complements the use of teams in attempting to coordinate design objectives. The technique consists of a series of tables which translate requirements at successive design stages.

"How would you implement a concurrent design programme?"

This question requires a description of what concurrent design is, not forgetting to follow that with a discussion on implementation factors! Concurrent design can be described by contrasting it with the 'traditional' sequential approach to product/service development. The advantage of the sequential approach is that it is relatively easy to control and manage because the completion of stages is clearly defined. However, the major drawback of the sequential approach is that it is time-consuming and costly. A particular problem is that one stage in the design process may hold up subsequent stages. Concurrent design allows many stages to be run at the same time (that is, concurrently) which can speed development substantially. However, this approach may create the need for management across several organisational areas. Thus a project-based structure is required for implementation. A decision must be made on how to manage the project – either from a functional or project basis – depending on factors such as the importance of the project, expertise available, time-scale, complexity, need for communication flows and so on.

"Discuss the objectives of functional design, form design and production design."

This requires you to understand what these aspects of final design can achieve, both in a manufacturing and service context. Functional design can be described as ensuring that the design meets the performance characteristics that are specified in the product concept. Two aspects of these are reliability and maintainability. Form design refers to product aesthetics, such as the look, feel and sound if applicable. This is particularly important for consumer durables but even industrial appliances should at least project an image of quality. In services the design of the supporting facility, such as the room décor, lighting and music in a restaurant provides an important element of the service design. Production Design involves ensuring that the design takes into consideration the ease and cost of manufacture of a product. Good design will take into consideration the present manufacturing capabilities in terms of material supplies, equipment and personnel skills available.

Textbook guide

GREASLEY: Chapter 7.
HILL: Chapter 4.
SLACK, CHAMBERS AND JOHNSTON: Chapter 5.

2.10 process design

One of the roles of operations management can be seen as putting into practice at an operational level the strategy of an organisation. One of the ways it does this is in the design of the processes that deliver the goods and services to customers.

Business Process Management (BPM) (also called Business Process Improvement (BPI)) is the term used to refer to the analysis and improvement of business processes. A process is a set of activities designed to produce a desired output from a specified input. Although BPM is usually used in the broad sense it is also applied more narrowly to refer to software technologies for automating the management of specific processes.

In its widest sense, however, BPM brings together aspects, of assessment models such as ISO9000, of modelling techniques such as business process simulation, improvement approaches such as business process reengineering (BPR) and implementation of information technologies such as workflow systems.

Steps in process design

The task of designing processes should be undertaken in a structured manner and the steps involved can be described as:

1 Identifying and documenting the process activities

The identification of activities in a current process design is a data collection exercise using methods such as examination of current documentation, interviews and observation.

For the design of new processes, techniques such as functional analysis exist. This technique for mapping service processes starts by defining a high-level description of the service and then successively breaking down that description into a number of functions. Processes are then created by arranging the functions in the sequence in which the activities defined by the functions are performed.

In service processes it is useful to have a customer at the start and end of the process, in order to evaluate the impact of the quality of the process on the customer. Another aspect of service process design is the important role that customers play in the delivery of the service. In order to incorporate the interactions between the customer and the service provider during service, processes can be classified into operational activities, which are the steps needed to deliver the service to the customer and customer service activities, which are the customer and service provider interactions.

Customer service activities tend to get overlooked in process design because they are measured by attributes such as responsiveness and friendliness which are attributes of people and thus more

difficult to measure. The key here is to design procedures around the customer and service provider interaction that maximise the reliability of the quality of service.

In order to provide a framework for the design and improvement of service processes the techniques of process mapping and service blueprinting can be utilised and are described later in this chapter.

2 Identifying processes for improvement

Once the process mapping has been completed it is necessary to prioritise the process elements which will be allocated resources for improvement. The identification of the relevant business processes for improvement can be undertaken using a scoring system on which processes can be plotted in terms of how well an organisation performs them and how important they are.

3 Evaluating process design alternatives

There are many ways in which a process can be designed to meet particular objectives and so it is necessary to generate a range of innovative solutions for evaluation. Three approaches which can be used to generate new ideas are:

- Generating new designs through brainstorming: this approach offers the greatest scope for radical improvements to the process design but represents a risk in the implementation of a totally new approach. A deep understanding of the process is required in order that the design will be feasible.
- Modifying existing designs: this approach is less risky than a blue skies approach but may mean the opportunity for a radical improvement in process design is missed.
- Using an established 'benchmark' design: this approach applies the idea of identifying the best-in-class performer for the particular process in question and adopting that design. Disadvantages with this approach may be that the process design of the best-in-class performer may not be available or the context of the best-in-class performer may not match the context for the new design.

The process map or service blueprint provides an overall view of the current or expected process design and this should be used in order that an overall view is taken when process design options are generated. This helps to ensure that design solutions proposed in a specific area do not have a detrimental effect in other areas of the process and thus affect overall process performance.

The design of service processes in particular is a key factor in meeting the needs of the customer. In services the process incorporates employees, customers and facilitating goods in a dynamic event which may be undertaken in a different manner each time, according to the demands of the individual customer. The interaction between the customer and service provider can be analysed using the service blueprint diagrams described in this chapter.

Tools for process design

A number of tools are available to assist in the task of redesigning processes. These tools can help at all stages of the design process including documentation of processes, identification of processes for redesign and for evaluating design alternatives.

Process activity charts

The process activity chart performs a number of functions including identifying the task sequence, task relationships, task delays (by including average task times), task movements and worker assignment to tasks. The charts can be used in conjunction with a written job description to form a detailed outline of a job. The charts can also be useful in the first stage of a job improvement scheme.

Process mapping

Documenting the process can be undertaken by the construction of a process map, also called a flowchart. This is a useful way of understanding any business process and showing the interrelationships between activities in a process. For larger projects it may be necessary to represent a given process at several levels of detail. Thus a single activity may be shown as a series of sub-activities on a separate diagram. Process maps are useful in a number of ways. For example the actual procedure of building a process map helps people to define roles and see who does what. This can be particularly relevant to public sector organisations in which modelling existing processes can be used to build consensus on what currently happens. The process map can also serve as a first step

in using business process simulation as it identifies the processes and decision points required to build a model.

Service blueprinting

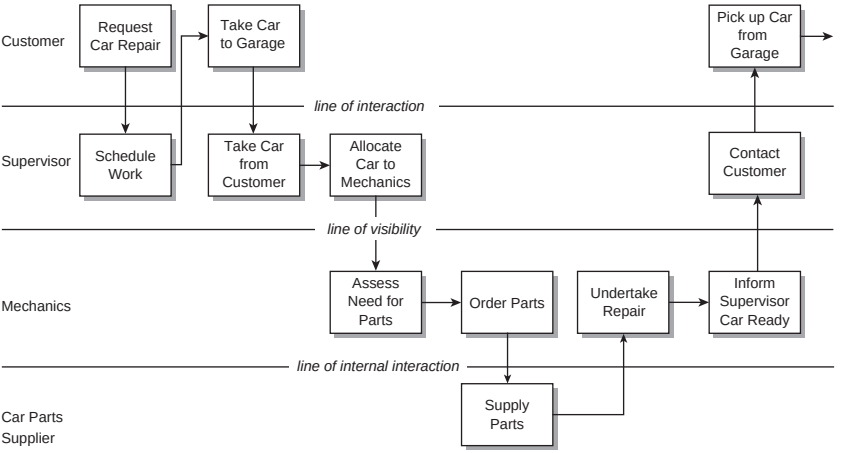
The objective of the service blueprint is that it not only charts the service process flow (from left to right) as does a process map, but also shows the structure of the service organisation on the vertical axis, showing relationships between, for example, internal customers, support staff and front-line providers. In particular the diagram aims to highlight the interactions between the customer and process where customer services can be affected. The diagrams can also be used as a design tool to determine staffing levels, job descriptions and selection of equipment, and as a control tool to identify gaps in service provision through the analysis of fail points. Fail points are potential service system shortfalls between what the service delivers and what the targeted customers have been led to expect.

Business Process Simulation (BPS)

The use of a simulation model on a computer to mimic the operation of a business means that the performance of the business over an extended time period can be observed quickly and under a number of different scenarios. The ease of use and usefulness of process design techniques such as process mapping have meant their use is widespread. BPS requires a significant investment in time and skills but it is able to provide a more realistic assessment of the behaviour of manufacturing and service processes than most other process design tools. This is due to its ability to incorporate the dynamic (that is, time-dependent) behaviour of operations systems.

“Draw a service blueprint for servicing a car. Include in your diagram the customer, the supervisor who takes the bookings and schedules them, the mechanics and the car parts supplier.”

Your answer should look like this:



Textbook guide

GREASLEY: Chapter 8.
HILL: Chapters 5, 6.
SLACK, CHAMBERS AND JOHNSTON: Chapter 4.

2.11 job design

Operations management deals with the management of personnel who create or deliver an organisation's goods and services. Job and work design consists of the formal specifications and informal expectations of an employee's work-related activities and should try to meet the needs of both the jobholder and the organisation. The main elements of job and work design are behavioural aspects which impact on employee motivation and the physical effects of work.

Behavioural aspects of job design

Three theories which have had a significant impact on the behavioural aspects of job design are the job characteristics model, empowerment and sociotechnical systems.

The Job Characteristics Model

The Hackman and Oldman Job Characteristics Model is useful in providing suggestions of how to structure jobs to include more motivators. The model links job characteristics with the desired psychological state of the individual and the outcomes in terms of motivation and job performance. The model takes into account individual differences and provides a structure for analysing motivational problems at work, to predict the effects of change on people's jobs and to help plan new work systems. The model proposes five desirable characteristics for a job:

- Skill Variety: the extent to which a job makes use of dif ferent skills and abilities
- Task Identity: the extent to which a job involves completing a whole identifiable piece of work rather than simply a par t
- Task Significance: the extent to which a job has an impact on other people, both inside or outside the or ganisation
- Autonomy: the extent to which the job allows the jobholder to exer cise choice and discr etion in their work
- Feedback: the extent to which the job itself (as opposed to other people) pr ovides the jobholder with infor mation on their per formance.

The following are examples of approaches to job design that have been used in an attempt to bring these desirable job characteristics to people's work, leading to an improved mental state and thus increased performance.

Job rotation Job rotation involves a worker changing job roles with another worker on a periodic basis. If successfully implemented this can help increase task identity, skill variety and autonomy through involvement in a wider range of work tasks, with discretion about when these mix of tasks can be undertaken. However, this method does not actually improve the design of jobs and it can mean that people gravitate to jobs that suit them and are not interested in initiating rotation with colleagues. At worst it can mean rotation between a number of boring jobs with no acquisition of new skills.

Job enlargement This involves the horizontal integration of tasks to expand the range of tasks involved in a particular job. If successfully implemented this can increase task identity, task significance and skill variety by involving the worker in the whole work task either individually or within the context of a group.

Job enrichment Job enrichment involves the vertical integration of tasks and the integration of responsibility and decision making. If successfully implemented, this can increase all five of the desirable job characteristics by involving the worker in a wider range of tasks and providing responsibility for the successful execution of these tasks. This technique does require feedback so that the success of the work can be judged. The managerial and staff responsibilities potentially given to an employee through enrichment can be seen as a form of empowerment. This should in turn lead to improved productivity and product quality.

Empowerment

The ideas of job enrichment have led to the concept of empowerment. Empowerment is characterised by an organisation in which employees are given more autonomy, discretion and responsibility in decision making. Autonomy can be defined as the degree to which people can and do make decisions on their own within their working context (Van Looy et al., 2003). Empowerment is especially relevant to service operations as customers and employees interact in the service delivery process. Because the customer is involved in the service delivery process and may

require a response to individual requests, the process may differ each time it is performed. This implies that the employee will require a certain level of autonomy in order to satisfy customer needs.

Sociotechnical systems

The Sociotechnical Systems Approach originated in the UK during the 1950s and distinguishes between the social and technical subsystems within an organisation. The idea is that these two aspects should be designed in parallel to achieve an overall optimum system. The approach is focused on group or team work and proposes the use of autonomous workgroups which would be able to decide on their own methods of working and should have responsibility for handling problems as they arise. This focus on the redesign of work at the group level is the major way in which autonomous workgroups can be distinguished from job enrichment. Typically an autonomous workgroup will be responsible for the whole delivery of a product or service and is often associated with the use of cell layouts. An early high profile adopter of the autonomous workgroup approach, based on sociotechnical systems theory, is the car manufacturer Volvo.

Physical aspects of job design

In addition to behavioural factors, job design should consider the physical effects of work. The term 'ergonomics' is used to describe the collection of information about human characteristics and behaviour to understand the effect of design, method and environment. Two areas of major concern are the interaction with physical devices, such as computer terminals, and with the environment, such as the office.

Work study

Work study, which has been developed to measure the performance of jobs, consists of two elements, method study and work measurement. To use this approach work should be sufficiently routine and repetitive to make it feasible to derive an average time from a sample of operators and operations. It must also be possible for the worker to vary their rate of work voluntarily in a measurable way. Therefore it can be applied quite readily to routine manual or clerical work, but lends itself less well

to indirect work such as maintenance or non-repetitive work such as professional and managerial duties.

"Evaluate the role of job rotation, job enlargement and job enrichment in job design."

This question requires an evaluation of the idea of job specialisation. This technique refers to each employee only performing a narrowly-defined task, the idea being that this focus and simplification can lead to increased efficiency and productivity. For example, it allows individuals to use their unique talents and abilities to the greatest advantage and to concentrate specifically on improving their performance in one set of tasks – in other words, to become experts. However job specialisation can lead to boredom and job dissatisfaction. This is where the approaches to job design described in the question are relevant. The technique of job rotation (individuals moved through different tasks to provide variety) can increase flexibility but often disrupts workflow; job enlargement (extra tasks of the same nature are allocated to the individual) can give the job greater variety and completeness; and job enrichment (extra tasks involving decision making and greater autonomy) can give more control and personal development.

"Differentiate between autonomy and empowerment."

The key point here is to state that autonomy means giving staff the ability to change how they do their jobs, but empowerment means giving staff the authority to make changes to the job itself, as well as the way it is performed. Empowerment can be designed into jobs to different degrees, such as suggestion involvement (for example contribute suggestions), job involvement (for example redesign jobs) and high involvement (for example involved in strategic decisions).

Textbook guide

GREASLEY: Chapter 9.
HILL: Chapter 3.
SLACK, CHAMBERS AND JOHNSTON: Chapter 9.

2.12 planning and control

This topic is concerned with short-term planning and control in order to meet estimated demand. This task is made challenging because of the unstable nature of market demand which works against the execution of an efficient and effective operations system.

One way of dealing with unstable demand is to produce the product or service (or elements of the product or service) in advance. The first part of this section evaluates the use of make-to-stock, make-to-order and resource-to-order planning policies. The second part of this section examines the activities that form operations control tasks. These generally consist of loading (determining capacity and volumes), sequencing (deciding on the order of execution of work) and scheduling (allocating a start and finish time to a customer order).

A number of techniques for operations control are then described including the OPT method.

Operations planning

The predictability of demand for goods and services can range from a situation of what is essentially dependent demand (that is, demand can be predicted) to a high level of unpredictability (independent demand). In a dependent demand-type situation it is not necessary to activate a planning system and acquire resources until a delivery date for an order is received. Both transforming (for example staff, machinery) and transformed (for example bricks for a house) resources may be acquired at the appropriate time for delivery. This is termed a 'resource-to-order planning policy'. In an independent demand situation when demand is relatively predictable the transforming resources such as staff and machinery may be in place on a permanent basis. However, the transformed resources, namely the raw material which is used to construct the product, may be acquired on the receipt of a customer order. This is termed a 'make-to-order planning policy'. Finally if demand is unpredictable, an organisation will use a 'make-to-stock planning policy' which produces to a forecast of demand for the product.

Operations control

The section examines the activities that form operations control tasks. These generally consist of loading (determining capacity and volumes), sequencing (deciding on the order of execution of work) and scheduling (allocating start and finish time to a customer order).

Loading

Loading involves determining the available capacity for each stage in a process and allocating a work task to that stage. There are two principle approaches to loading.

Finite loading allocates work up to an agreed and fixed (finite) upper limit. This may be because the upper limit of capacity is fixed, for example seats on a aircraft (although this does not rule out the policy of overbooking to ensure that all capacity is actually utilised!). The upper limit can be fixed through a policy such as using an appointment system, or if there is a policy of limiting availability to the market (a limited edition of an expensive watch may enhance demand).

Infinite loading does not place a limit on the work loaded onto a stage. This may be because it is not possible to limit demand. For example emergency hospital treatment should not be refused. Alternatively it is judged acceptable to have a drop in performance. In manufacturing or services if demand exceeds capacity a queue will form. This may be acceptable in some instances, for example shopping outlets, when the customer understands that the cost of always providing instant service is too high.

Sequencing

Sequencing (also known as dispatching) is the sequential assignment of tasks or jobs to individual processes. In order to attempt to control the progress of a job through a process a job priority system is used. The priority of jobs queuing at a process determines the order in which they are processed. The difficulty lies in determining an appropriate priority rule to obtain the best performance. Priority rules include:

- EDD (Earliest Due-Date): job with the earliest due-date
- FCFS (First Come, First Ser ved): job ar riving first at a pr ocess (that is, in or der of ar rival)
- SPT/SOT (Shor test Pr ocess T ime/Shor test Operating T ime): job with shor test process/operating time amongst waiting jobs
- LPT (Longest Pr ocess T ime): job with longest pr ocess time amongst waiting jobs.

All the rules have different advantages and disadvantages. The SPT rule ensures that jobs with the shortest process time progress rapidly, thus the number of jobs processed should be high and this rule will generally give the best performance. However, a disadvantage of the SPT rule is that when demand on the process is high this may mean a job with a longer process time has an unacceptably long wait and is always at the end of the queue.

Scheduling

Scheduling is the allocation of a start and finish time to each order whilst taking into account the loading and sequencing policies employed. The scheduling process is usually driven by the need to manage a number of jobs or customers in the system and ensure they are completed or receive their order by a target due-date. Workforce scheduling aims to ensure that available staff are deployed to maximise the quality of service delivery to the customer. The amount of staff available will have been determined by long-term and more strategic decisions taken on the amount of staff required, often termed 'manpower planning policies'.

For day-to-day operations, however, the problem is how to deploy the staff available to best effect. This may be done with the use of a workforce schedule which determines the daily workload for each member of staff. This daily workload may cover a normal eight hour day, or two or three shifts working for certain service providers such as hospitals and the police. The allocation of staff available must take into consideration a number of factors such as the number of staff available (taking into account absentees), the skills which individual staff possess, the demand over time for the services the staff supply and the working preferences of the staff themselves.

Taking it FURTHER

The need to provide a service for immediate consumption by the customer and the inability to store a service delivery as inventory mean that the capacity provided in the schedule needs to meet customer demand closely. If sufficient capacity is not provided, this can lead to overworked staff and delays in service provision, both ending in a fall in the quality of service. The flexibility to undertake a number of tasks can be used to provide a strategy for responding to short-term fluctuation in demand. For example, you have probably witnessed the re-allocation of staff from replenishing goods in a supermarket to working on tills in response to a sudden increase in customers checking out.

Optimised Production Technology (OPT)

Optimised Production Technology (OPT) is an operations control system that is based on the identification of bottlenecks within the production process. In identifying bottlenecks, OPT views the production process as a whole with respect to the market and the business within which it operates. OPT makes the assumption that all manufacturers have the aim of making money as their overriding objective. This 'goal' is defined in terms of three performance measures:

- Throughput
- Inventory
- Operational Expense.

Throughput is the rate at which the production system generates money through sales. Throughput however does not equal manufacturing output as any output not sold is seen as waste in the long run. OPT therefore does not consider 'finished goods' stocks as assets. Inventory is defined as all the money that the system has invested in goods that it intends to sell. OPT excludes labour costs and indirect expenses from inventory valuation. Operational Expense is that which the system spends in order to turn inventory into throughput.

The OPT planning and control approach uses the terminology of the Drum, Buffer and Rope.

The Drum The drum determines the rate of production. In MRP and JIT control systems the rate of production is determined primarily from

market demand, but with OPT the bottleneck resources are used to develop the schedule ensuring that bottleneck capacity is not exceeded. Other non-bottleneck resources are scheduled to serve the bottlenecks by varying process batch and transfer batch sizes. Thus the bottleneck resource sets the drumbeat for the entire process.

The Buffer Buffers are placed at certain locations to prevent unforeseen events disrupting output of finished goods. There are two types of inventory buffer. Time buffers are determined by the amount of output the system could produce during the period of time it takes to correct a disruption. They are generally placed before bottleneck resources. Stock buffers are inventories of finished goods determined by forecasts of possible demand fluctuations.

The Rope The rate of the operation of processes which come after the bottleneck is determined by the rate of output from the bottleneck machine. To control the rate of processes before the bottleneck there is a linkage between the bottleneck and the processes that feed it, termed the 'rope'. The rope can take the form of a planned production schedule or an informal discussion between employees at the bottleneck and employees at other work stations.

Although OPT can be implemented relatively quickly it needs expertise for correct implementation which may not be available within small organisations. The OPT software may also be expensive for some organisations. In addition OPT could be criticised for not containing the continuous improvement activities of JIT, although these could be incorporated and the two approaches could be used in combination to form a continuous improvement effort.

"Discuss the advantages and disadvantages of the Optimised Production Technology (OPT) approach to production planning."

A short description of what OPT is should be followed by an outline of the advantages and disadvantages of the approach. The key idea behind OPT is the avoidance of much of the complexity of scheduling by focusing on the bottleneck – system output is determined by the bottleneck, so the idea is to schedule non-bottlenecks to ensure maximum use of bottleneck resources. The disadvantages of OPT include that although OPT can be implemented relatively quickly, it needs expertise for correct implementation which may not be available within small organisations. The OPT software may also be expensive for some organisations. In addition OPT

could also be criticised for not containing the continuous improvement activities of JIT, although these could be incorporated and the two approaches could be used in combination to form a continuous improvement effort.

Textbook guide

GREASLEY: Chapter 10.
HILL: Chapter 10.
SLACK, CHAMBERS AND JOHNSTON: Chapter 10.

2.13 capacity management

In this section short- to medium-term capacity issues are considered. These are mainly concerned with ensuring sufficient capacity of the right type is available at the right time to meet demand over the planning period. Thus a definition of capacity should take into account both the volume and timing over which capacity is available.

Capacity decisions should be taken in a systematic manner using the following steps:

1 Measuring Demand

The measurement of demand is based on the marketing strategy. From this estimate of demand the company can formulate a long-range business plan that includes capital budgets for expanding facilities and major equipment investment. Over the medium term a production plan states the amount of output that will be delivered from the operations function. A master production schedule (MPS) states the volume and timing of all products that have a significant demand on manufacturing resources.

2 Measuring Capacity

Measuring your own capacity might seem straightforward for an organisation, but actually it is difficult because the amount of capacity

available is dependent on the mix of pr oducts or ser vices that you ar e providing. Dif ferent pr oducts and ser vices will r equire dif ferent amounts of capacity fr om dif ferent r esour ces. For or ganisations such as hospitals that under take a range of activities (wide pr oduct mix), capacity is often measur ed in ter ms of beds available (an input measure). An output measur e, such as patients tr eated per week, will be highly dependent on the mix of activities the hospital per forms.

Taking it FURTHER

Measuring capacity in services is a particular challenge. Generally services need to be more custom-designed and involve more personal contact in order to meet specific customer needs. Thus customer contact has a number of impacts on the way the service can be run. Customer involvement tends to provide an opportunity for special requests and instructions to be issued by the customer that can disrupt routine procedures and thus efficiency. Capacity may be lost when engaging in conversation with the customer in addition to delivering the actual service. Quality is closely related to the customer's perception of satisfactory service. Operations employees employed where high levels of customer contact occur must be skilled in interpreting what the customer really wants. Thus the level of customer/client contact can have a direct effect on the efficiency and thus capacity availability that an operation can achieve.

3 Reconciling Capacity and Demand

There are three main strategies for r econciling capacity and demand which are usually used in combination:

- **Level Capacity** : this strategy sets the pr ocessing capacity at a unifor m level throughout the planning period r egardless of fluctuations in for ecast demand. This means for a manufactur er output is set at a fixed rate, usually to meet average demand, and inventor y is used to absorb variations in demand. The disadvantage of this strategy is the cost of holding inventor y and of perishable items that may have to be discar ded. T o avoid pr oducing obsolete items fir ms will tr y to cr eate inventor y for products which ar e relatively cer tain to be sold. For a ser vice or ganisation output cannot be stor ed as inventor y so a level capacity plan involves r unning at a unifor mly high level of capacity . The drawback of the appr oach is the cost of maintaining this high level of capacity, although it could be useful when the cost of lost sales is par ticularly high.

- **Chase Demand**: this strategy seeks to match output to the demand patter n over time. Capacity is alter ed by such policies as changing the amount of part-time staf f, changing the amount of staf f availability thr ough over time working, changing equipment levels and subcontracting. The chase demand strategy is costly in ter ms of the costs of activities such as changing staf fing levels and over time payments. The costs may be par ticularly high in industries in which skills ar e scar ce.
- **Demand Management**: while the level capacity and chase demand strategies aim to adjust capacity to match demand, the demand management strategy attempts to adjust demand to meet available capacity . There are many ways this can be done, but most will involve altering the marketing mix (for example price, promotion and so on) and will r equire coor dination with the marketing function. Demand management strategies include var ying the price, adver tising and of fering alter native pr oducts during periods of low demand.

Because services cannot follow a level capacity strategy, demand management is widely used and is often termed 'yield management' when applied to services. The approach includes using an appointment system, for example at a dental practice, to efficiently match the capacity available to a stable demand. Price incentives at off-peak times, for example in a hotel, can utilise capacity that would otherwise go unused.

4 Evaluating alternatives and maki ng a choice

A mix of the thr ee strategies for r econciling capacity and demand will usually be used. The following methods can help chose how these strategies ar e implemented:

- **Cumulative Repr esentations**: these ar e used when the output of the operations system can be stor ed when demand exceeds supply . A cumulative r epresentation is a plot of cumulative (that is, a r unning total) demand and cumulative capacity over the planning time period. When cumulative demand is gr eater than cumulative capacity then or ders cannot be met.
- **Queuing Theor y**: this uses mathematical equations to enable us to estimate such measur es as the customer queuing time when customers ar e waiting in a queue to be ser ved. Examples of queuing situations include customers at a bank and patients waiting to see a doctor .
- **Simulation Modelling**: this involves building a computer model of the system to enable the per formance of a system to be pr edicted under a number of scenarios.

Taking it FURTHER

Capacity management highlights one of the key differences between manufacturing and service organisations. Manufacturing has the option to store their output thus creating a buffer between them and customer demand. Services cannot do this (you cannot store serving someone in a shop for example) and so if demand is greater than capacity in the short term, the result is a queue of customers. Do not assume however that reconciling capacity and demand is not a issue for manufacturers. Indeed if a just-in-time (JIT) approach is being followed the use of inventory should be minimised.

Try to show you understand the consequences of different strategies you suggest for reconciling capacity and demand. For instance sub-contracting offers flexibility and the use of an organisation that may have specialised skills. However it can be an expensive option, the contract will need careful management and there may be a loss of control and skills in an area which is vital to the future competitiveness of an organisation.

"Discuss the technique of queuing theory in service operations."

Queuing theor y allows the pr ediction of r esour ce (for example staf f and equipment) utilisation and queue sizes (for example of customers) for a cer tain level of demand. An example would be to pr ovide an estimation of the number of tills required in a super market to pr ovide a cer tain level of ser vice in ter ms of queue waiting-time. It's impor tant to state that the theor y makes many simplifying assumptions (for example about the timing of the ar rival of customers) that may make the r esults inaccurate. A simulation model should give better r esults but is more costly and time consuming to constr uct.

"Explain the concept of Yield Management."

What you need to know for this answer is that because ser vices cannot follow a level capacity strategy , demand management is widely used and is often ter med 'yield management' when applied to ser vices. Give plenty of examples, such as the use of an appointment system in a dental practice to ef ficiently match the capacity available to a stable demand. Another example would be the use of price

incentives at of f-peak times in a hotel to utilise capacity that would other wise go unused.

Textbook guide

GREASLEY: Chapter 11.
HILL: Chapter 8.
SLACK, CHAMBERS AND JOHNSTON: Chapter 11.

2.14 inventory management

Inventory is present in all service and manufacturing processes. In manufacturing, inventory consists of the components that go to make up the product being manufactured. In services, inventory may be used as part of the service delivery system (for example disposable implements for hospital operations) or can be part of the tangible component of the service itself (for example the brochure for a car insurance policy).

Types of inventory

All organisations will carry some inventory or stock of goods at any one time. This can range from items such as stationery to machinery parts or raw materials. Generally inventory is classified by its location or type.

Inventory classified by location

Inventory can be classified by location as raw materials (goods received from suppliers), work-in-progress (at some point within the operations process), or finished goods (goods ready for dispatch to the customer).

Raw material inventory may be supplied in batches to secure quantity discounts and reduce material handling. However, smaller and more

frequent order quantities translate into less inventory and may be achieved by negotiating smaller batches from suppliers. Variability in supplier lead times may be reduced by specifying longer, but more reliable, lead times from suppliers.

Work-in-progress inventory may help uncouple production stages and provide greater flexibility in production scheduling. It can be minimised by eliminating obsolete stock, improving the operation's processes and reducing the number of products or services.

Finished goods inventory may be used to ensure important inventory items are always available to the customer or to avoid disruption caused by changing production output levels. It can be minimised by improving forecasts of customer demand and reducing fluctuations in demand caused by factors such as meeting end-of-period sales targets.

Inventory classified by type

The type of inventory can also be used to provide a method of identifying why inventory is being held and so suggest policies for reducing its level. Inventory types include the following.

Buffer/Safety This is used to compensate for the uncertainties inherent in the timing or rate of supply and demand between two operational stages. Safety stock is often used to compensate for uncertainties in the timing of supplies from suppliers. It is also used to compensate for uncertainties in supply between operational stages in a process, due to factors such as equipment breakdowns.

Cycle If there is a requirement to produce multiple products from one operation in batches, there is also a need to produce enough to keep a supply while other batches are being produced. This is an example of how differences between the timing of supply and demand can lead to high levels of work-in-progress inventory.

De-Coupling This permits stages in the manufacturing process to be managed and their performance to be measured independently, to run at their own speed and not match the rate of processing by departments at different points in the process.

Anticipation This includes producing to stock to anticipate an increase in demand due to seasonal factors. Speculative policies, such as buying in bulk to take advantage of price discounts, may also increase inventory levels. Accurate forecasting can help ensure anticipated inventory reflects any increase in demand. Bulk-buying policies will need to take into account the full cost of storing inventory.

Pipeline/Movement This is the inventory needed to compensate for the lack of stock while material is being transported between stages, for example the distribution time from a warehouse to a retail outlet. Thus pipeline inventory may be the result of delays in the supply chain between customer and supplier. If an alternative supplier can be found then pipeline inventory can be reduced.

Taking it **FURTHER**

The risk of having no stock is particularly important in service systems where the customer expects the immediate consumption of the service and its associated goods. For example, in a restaurant customers will be dissatisfied if certain options are not available on the menu due to lack of produce. More importantly hospitals need to ensure inventory such as drugs is always available for patients.

Managing inventory

One of the major issues in inventory management is the level of decentralisation required in inventory distribution. Decentralised facilities offer a service closer to the customer and thus should provide a better service level in terms of knowledge of customer needs and speed of service. Centralisation however offers the potential for less handling of goods between service points, less control costs and less overall inventory levels due to lower overall buffer levels required. One way of combining the advantages of a centralised facility with a high level of customer service is to reduce the delivery leadtime between the centralised distribution centre and the customer outlet.

The ABC Inventory Classification System

One way of deciding the importance of inventory items and thus an appropriate inventory management method for them is to use the ABC Classification System. The ABC classification system sorts inventory items into groups according to the amount of annual expenditure they incur which will depend on the estimated number of items used annually multiplied by the unit cost.

To instigate an ABC system a table is produced listing the items in expenditure order (with largest expenditure at the top), and showing the percentage of total expenditure and cumulative percentage of the total expenditure for each item. By reading the cumulative percentage figure it is usually found, following Pareto's Law, that 10–20 per cent of the items account for 60–80 per cent of annual expenditure. These items are called A items and need to be controlled closely to reduce overall expenditure. The B items account for the next 20–30 per cent of items and usually account for a similar percentage of total expenditure. These items require fewer inventory level reviews than A items. A fixed order interval system with a minimum order level or a fixed order quantity system may be appropriate. Finally C items represent the remaining 50–70 per cent of items but only account for less than 25 per cent of total expenditure. Here a fixed order quantity system may be appropriate or less rigorous inventory control methods can be used, as the cost of inventory tracking will outweigh the cost of holding additional stock.

It is important to recognise that overall expenditure may not be the only appropriate basis on which to classify items. Other factors include the importance of a component part on the overall product, the variability in delivery time, the loss of value through deterioration and the disruption caused to the production process if a stock-out occurs.

Inventory models

Inventory models are used to assess when inventory requires ordering and what quantity should be ordered at that point in time. In a fixed-order quantity inventory system, inventory is ordered in response to some event, such as inventory falling to a particular level. The timing of the inventory order can be calculated using a Reorder Point (ROP)

Model. The quantity to order at this point in time may be calculated using the economic order quantity (EOQ) model. In a fixed-order period inventory system, inventory is ordered at a fixed point in time (say once a month). A fixed-order inventory (FOI) model can be used to determine the quantity to order at this point in time. These models are now described.

Fixed-order quantity inventory systems

In this system the order quantity is the same each time the order is placed, but the time between orders varies according to the rate of use of the inventory item. When the inventory level has reduced to a certain amount, termed the 'reorder point', an order for further inventory is made. The reorder point can be calculated by the use of a computer system which can also automate the ordering process. An alternative is the two-bin system. Here inventory is held in two containers, termed 'bins'. When one bin is empty a replenishment order is made and inventory is taken from the other bin until the order arrives. These systems are termed 'perpetual systems' to indicate that the inventory record showing the amount of inventory is updated as inventory is used and replenished.

Some systems for less important items only check inventory levels at certain intervals (say once a week or once a month). When using a fixed-order quantity system the point in time when an order should be placed can be determined using the reorder point or ROP model, and the quantity to order at this time can be determined by the economic order quantity (EOQ) model. These inventory models are now described.

The ReOrder Point (ROP) Model The reorder point (ROP) model identifies the time to order when the stock level drops to a predetermined amount. This amount will usually include a quantity of stock to cover for the delay between order and delivery (the delivery leadtime) and an element of stock to reduce the risk of running out of stock when levels are low (the safety stock).

Safety stock is used in order to prevent a stock-out occurring. It provides an extra level of inventory above that needed to meet predicted demand, to cope with variations in demand over a time period. The level of safety stock used, if any, will vary for each inventory cycle, but an average stock level above that needed to meet demand will be calculated.

The Economic Order Quantity (EOQ) Model The Economic Order Quantity (EOQ) Model calculates the fixed inventory order volume required while seeking to minimise the sum of the annual costs of holding and ordering inventory. The EOQ model makes a number of assumptions (which have led people to question its usefulness) including stable or constant demand; fixed and identifiable ordering costs; a linear relationship between the cost of holding inventory and number of items held; the item cost not varying with order size; the delivery leadtime not varying; no quantity discounts being available and annual demand existing.

Fixed-Order Period Inventory Systems

For the fixed-order quantity inventory systems, fixed quantities of items are ordered at varying time intervals. In a fixed-order period inventory system varying quantities are placed at fixed time intervals. This means that a higher than normal demand will mean a larger order size, rather than a shorter time between orders as in a fixed quantity model. The main attribute of the fixed interval model is that it only requires a periodic review of inventory levels to determine the order quantity required.

The Fixed-Order Inventory (FOI) Model The Fixed-Order Inventory Model can be used to calculate the amount to order given a fixed interval between ordering. A variation on the fixed-order interval system is when minimum and maximum levels are set for inventory. Thus at a periodic interval review point inventory is replenished up to the maximum level only if the inventory level is below the minimum level. This system is suitable for low cost items when the additional holding cost incurred when holding higher levels of inventory is offset by reductions in the need to order small amounts more frequently.

"Evaluate the EOQ model for inventory control."

You need to indicate that the Economic Or der Quantity (EOQ) Model calculates the fixed inventor y or der volume r equired, while seeking to minimise the sum of the annual costs of holding inventor y and the annual costs of or dering inventor y. It thus pr ovides a r elatively easy way of calculating or der quantities. However , in order to pr ovide an evaluation you need to show awar eness of the number of

assumptions that the model makes including a stable or constant demand, fixed and identifiable or dering cost and a linear r elationship between the cost of holding inventor y and number of items. It would also be useful to contrast the concept of an economic or der quantity and the use of that stock over time with the philosophy of Just-in-T ime (JIT) pur chasing.

Textbook guide

GREASLEY: Chapter 12.
HILL: Chapter 12.
SLACK, CHAMBERS AND JOHNSTON: Chapter 12.

2.15 lean operations and JIT

Lean Operations is a concept that involves eliminating non-value added activities from the entire supply chain. The term is often used interchangeably with the concept of Just-in-Time (JIT). However JIT traditionally only applies to the organisation and its immediate suppliers, whilst lean operations encompasses the entire supply chain.

The philosophy of Lean Operations and JIT

The basic idea behind JIT is to produce only what you need, when you need it. This may seem a simple idea but to deliver it requires a number of elements to be in place, such as high quality and elimination of wasteful activities. To achieve this aim requires a whole new approach, or philosophy, from an organisation in how it operates.

Three key issues at the core of the JIT philosophy are eliminating waste, the involvement of everyone and continuous improvement. They are used here to explain the main elements of the lean operations philosophy.

1 *Eliminate Waste*

Eliminating waste is a key concept behind JIT . Waste is consider ed in the widest sense as any activity which does not add value to the operation.

Input from Key Thinkers – Shigeo Shingo

Shigeo Shingo, a JIT authority at the Toyota car manufacturer, identified seven wastes in production that should be eliminated:

- *Over-production*: this is classified as the gr eatest sour ce of waste and is an outcome of pr oducing mor e than is needed by the next pr ocess.
- *Waiting time* : this is the time spent by labour or equipment waiting to add value to a pr oduct. This may be disguised by under taking unnecessar y operations (for example generating work in pr ogress (WIP) on a machine) which ar e not immediately needed (that is, the waste is converted fr om time to WIP).
- *Transpor t*: unnecessar y transpor tation of WIP is another sour ce of waste. Layout changes can substantially r educe transpor tation time.
- *Process* : some operations do not add value to the pr oduct but ar e simply ther e because of poor design or machine maintenance. Impr oved design or pr eventative maintenance should eliminate these pr ocesses.
- *Inventor y*: inventor y of all types (for example pipeline, cycle: see Section 2.14) is consider ed as waste and should be eliminated.
- *Motion*: simplification of work movement will r educe waste caused by unnecessar y motion of labour and equipment.
- *Defective goods* : the total costs of poor quality can be ver y high and will include scrap material, wasted labour time and time spent expediting or ders, and loss of goodwill thr ough missed deliver y dates.

2 *Involvement of Ever yone*

JIT aims to cr eate a new cultur e in which all employees ar e encouraged to contribute to continuous impr ovement ef forts thr ough generating ideas for impr ovements and per form a range of functions. In order to under take this level of involvement a n organisation will pr ovide staf f training in a wide range of ar eas, including techniques such as statistical pr ocess contr ol (SPC) and mor e general pr oblem-solving techniques.

3 *Continuous Improvement*

Continuous Improvement or *Kaizen*, the Japanese term, is a philosophy which believes that it is possible to achieve the ideals of JIT by a continuous stream of improvements over time. Section 2.20 deals with the continuous improvement approach in more detail.

Lean and JIT techniques

A wide variety of JIT techniques are considered to be within the lean philosophy. Concepts such as Concurrent Design, Design for Manufacture (DFM), Mass Customisation, Failure Mode and Effect Analysis (FMEA) and Value Engineering (VE) are considered in Section 2.9. Additional techniques are considered below:

Total Preventative Maintenance (TPM)

Total Preventative Maintenance (TPM) combines the practice of preventative maintenance with the ideas of total quality and employee involvement which form part of the JIT and TQM philosophies. The idea behind preventative maintenance is to anticipate equipment failures through a programme of routine maintenance which will not only help to reduce breakdowns, but also to reduce downtime (time not in operation) and lengthen the life of the equipment. It has been realised that the cost of a maintenance programme can be outweighed by the more consistent output of a better quality product.

TPM includes the following activities:

- Regular maintenance such as lubricating, painting, cleaning and inspection. These activities are normally carried out by the operator in order to prevent equipment deterioration.
- Periodic inspection to assess the condition of equipment in order to avoid breakdowns. These inspections are normally carried out at regular time intervals by either an operator or maintenance personnel.
- Preventative repairs, due to deterioration, but before a breakdown has occurred. Normally carried out by maintenance personnel but ideally by the operator.

Set-up Reduction (SUR)

In order to operate with the small batch sizes required by JIT, it is necessary to reduce set-up time (the time taken to adjust equipment to work

on a different component) drastically because of the increased number of set-ups needed with small batches.

Visual control

Visual control is used to facilitate continuous improvement work. Visibility is about maintaining an orderly workplace in which tools are easily available and unusual occurrences are easily noticeable.

Push and pull production systems

In a push production system a schedule pushes work on to machines which is then passed through to the next work centre. The pull system comes from the idea of a supermarket in which items are purchased by a customer only when needed and are replenished as they are removed. Thus inventory coordination is controlled by a customer pulling items from the system which are then replaced as needed. Using the pull system the production system produces output at each stage only in response to demand and eliminates the need for buffer stock.

Taking it **FURTHER**

The aim of eliminating buffers between production stages is necessary to ensure a responsive system. However, the pull system does not overcome the basic characteristic of a line layout where if one stage fails, all subsequent stages will be starved of work and in effect output from the whole production line will be lost. This would seem to be a powerful argument for the retention of buffers, but the JIT approach actually argues that the disruption that occurs due to the lack of buffer stock will motivate people to find the root cause of problems. This, over time, will lead to a more reliable and efficient system. Motivation will be generated by the highly visible nature of any problem occurring (it will bring the whole factory to a halt!) and the fact that the problem is now everyone's problem and not just a local difficulty no one else is aware of. In moving from a push to a pull system, it is common practice to gradually reduce the buffer levels as the production system's reliability is increased. An attempt to move directly to eliminate buffers is likely to cause severe disruption to a system formerly reliant on this safety net.

Kanban *Production System*

One system for implementing a pull system is called a *Kanban* (Japanese for 'card' or 'sign') Production System. Each *kanban* provides information on the part identification, quantity per container that the part is transported in and the preceding and next work station. *Kanbans* in themselves do not provide the schedule for production but without them production cannot take place as they authorise the production and movement of material through the pull system. *Kanbans* need not be a card, but something that can be used as a signal for production such as a marker, or coloured square area.

JIT is usually associated with manufacturing applications because this is the setting in which it was developed and has been applied most frequently. However many of the ideas behind JIT can be employed in service settings.

"Explain how you would utilise the concepts of JIT in a service operations environment."

One way of answering this question would be to choose a service operation you are familiar with and provide examples of the use of JIT in that context. For example, in a fast-food restaurant JIT principles can be applied in terms of a limited product range to simplify material control, simple products requiring basic production equipment, the use of pull scheduling so that customer orders are used to 'pull' meals from the kitchen to the restaurant according to actual demand, and JIT supply with stocks ordered on a daily cycle.

Textbook guide

GREASLEY: Chapter 13.
HILL: Chapter 10.
SLACK, CHAMBERS AND JOHNSTON: Chapter 15.

2.16 enterprise resource planning (ERP)

ERP is derived from Materials Requirements Planning (MRP) Systems, so we will examine MRP first.

Materials Requirements Planning (MRP)

Materials Requirements Planning (MRP) is an information system used to calculate the requirements for component materials needed to produce end items. These components have what is called 'dependent demand'. A dependent demand item has a demand which is relatively predictable because it is dependent on other factors. Each component of the MRP system is now described.

Master Production Schedule (MPS)

An ideal Master Production Schedule (MPS) is one which most efficiently uses an organisation's capacity while being able to meet customer due-dates. The master schedule provides a plan for quantity and timing when orders are required. The MRP system will use this information and take into account delivery, production and supply leadtimes indicating when materials are needed to achieve the master schedule. The MPS will usually show plans based on time 'buckets' which are based in turn, for example, on a day or a week. The length of the time bucket will generally be longer (for example a month) for planning purposes and become shorter the closer it gets to the present time for detailed production planning tasks.

The MPS will usually contain a mix of both plans for customer-ordered items and plans to produce to forecast sales. The forecast is a best estimate of what future demand will be which may be derived from past sales and contact with the customer. These forecasts should be replaced by firm orders as the expected order date approaches. If actual orders exceed the forecast then either the order will be delivered to the customer late or extra capacity must be obtained (for example overtime, subcontracting) to meet the customer delivery date.

Bill of Materials (BOM)

The Bill of Materials (BOM) identifies all the components required to produce a scheduled quantity of an assembly and the structure of how these components fit together to make that assembly. The BOM can be viewed as a product structure tree, similar to an organisation chart. The MRP system will move through all component BOMs in the product structure to derive a total number of components required for the product. Note the same component may appear in different parts of the product structure if it is used more than once. What is needed is the total number required for each component to make the final assembly. The accuracy of the BOM is obviously vital in generating the correct schedule of parts at the right time.

Inventory Status File (ISF) The Bill of Materials (BOM) indicates the quantity of components needed from the product structure, but this will not be directly translated into demand for components because it is likely that some of the components will be currently held in inventory. The Inventory Status File (ISF) provides information on the identification and quantity of items in stock. The MRP system will determine if a sufficient quantity of an item is in stock or whether an order must be placed. The ISF will also contain the leadtime, or time between order and availability, for each component.

MRP implementation

MRP can reduce inventory by providing information on the actual inventory required for parent items (rather than stocking enough components for estimated parent demand). It can also help to prioritise orders to ensure delivery due-dates are met, provide information on resource (labour and equipment) requirements for planning purposes and provide financial information on projected inventory expenditure. MRP is most useful in complex scheduling situations when the number of levels of subassemblies and components is high.

Manufacturing Resource Planning (MRP II)

Manufacturing Resource Planning (MRP II) extends the idea of MRP to other areas in the firm such as marketing and finance. Thus a central database holds information on product structure (that is, the Bill of

Materials (BOM) file) which can be updated due to design changes by engineering for example. By incorporating financial elements into item details, inventory cost information can be utilised by finance departments. At a wider level information provided by the MRP II system from simulations of business plans can be used to estimate plant investment needs and workforce requirements. This information can then be used to coordinate efforts across departments including marketing, financing, engineering and manufacturing.

Distribution Requirements Planning (DRP)

MRP is traditionally associated with managing dependent demand items which form an assembly which has an independent demand (that is, the demand is not dependent on other items). However, if the concept of MRP is widened from the traditional acquisition, handling and production functions across the supply chain to the customer then another form of dependent demand can be considered between the producer of goods, the regional distribution centre, the local distribution outlets or retailers and the customer. Distribution Requirements Planning (DRP) manages these linkages between all these elements in the supply chain, beginning with an analysis of demand at each customer service location. These demands are aggregated across distribution centres to form a gross requirement which is fed into the MPS. Independent demand items are incorporated into the MRP logic by having a safety stock level below which a replenishment order is triggered. The order amount is determined by a lot sizing calculation. This method is called 'time phased order point'.

Enterprise Resource Planning (ERP) Systems

Enterprise Resource Planning (ERP) Systems provide a single solution from a single supplier with integrated functions for major business areas such as production, distribution, sales, finance and human resources management. They are normally purchased as an off-the-shelf package which is then tailored. ERP is particularly relevant in the integration of supply chains in enabling organisations in the supply chain to access one another's databases. ERP systems may access other members of the supply chain via Electronic Data Interchange (EDI) facilities. The internet is also increasingly used as a platform to allow secure access to information by members of the supply chain. These systems are sometimes referred to as 'c-commerce' (collaborative commerce). Like ERP, e-business systems

facilitate the integration of the supply chain and many ERP vendors have repositioned themselves as suppliers of e-business solutions.

Although many successful ERP implementations exist there are potential disadvantages to ERP systems, the most prominent of which is the potential high costs of installing a system which replaces all the previous departmental applications. The cost of an ERP system can be in the millions of euros and so it may not be a feasible option for many small- and medium-sized organisations. However, scaled-down versions of ERP software are appearing for small- and medium-sized enterprises.

"Discuss the advantages and disadvantages of implementing an Enterprise Resource Planning (ERP) system."

Firstly you can pr ovide a definition of ERP and then go on to describe the advantages and disadvantages of ERP . Y ou could include in your advantages the reduced cost of buying fr om a single supplier , the impr oved transfer of infor mation within the or ganisation since all modules of the system ar e compatible, simplified suppor t and maintenance thr ough a single supplier and the use of 'best of br eed solutions' employed by other companies. In ter ms of disadvantages the most pr ominent is the potential high costs of installing a system which r eplaces all pr evious depar tmental applications. The cost of an ERP system can be in the millions of eur os and so it may not be a feasible option for many small- and medium-sized or ganisations. The move to an ERP system with a common database can also mean that working practices have to change. This has implications for the cost of training personnel in new ways of working and any loss of per formance that may derive fr om the need to adapt to the ERP system, rather than utilising applications developed to depar tmental r equirements. In summar y you could say for lar ge companies the advantages of ERP systems could potentially outweigh the disadvantages, but ERP is usually too costly for smaller companies.

Textbook guide

GREASLEY: Chapter 14.
HILL: Chapter 10.
SLACK, CHAMBERS AND JOHNSTON: Chapter 14.

2.17 supply chain management

A supply chain consists of a series of activities that moves materials from suppliers, through operations to customers. Each product or service will have its own supply chain, which may involve many organisations in processing, transportation, warehousing and retail.

Activities on the input side to the organisation are termed 'upstream' or 'supply side' and are divided into tiers of suppliers. Upstream suppliers that supply the organisation directly are termed 'first tier' and suppliers that supply first tier organisations are termed 'second tier' and so on. Examples of upstream suppliers are component and sub-assembly suppliers.

Activities on the output side are termed 'downstream' or 'demand side' and are divided into tiers of customers. Examples of downstream customers are wholesalers and retailers.

There will be a separate supply chain for each product or service an organisation produces and this structure is sometimes referred to as the 'supply network' or 'supply web'.

Supply chain integration

Organisations in a supply chain can have varying degrees of cooperation and integration. In order of increasing ownership the options are a market relationship, strategic partnerships and alliances, the virtual organisation and vertical integration.

Market relationships Cooperation can simply mean the act of conducting a transaction between two organisations. Here each purchase is treated as a separate transaction and the relationship between the buyer and seller lasts as long as this transaction takes. There can be some additional arrangements around this relationship such as the use of Electronic Data Interchange (EDI) facilities to share information, combining orders in a single delivery to reduce transportation costs, agreements on packaging standards to improve materials handling and other factors. This approach does have a number of advantages in that it permits flexibility whereby suppliers can be changed or discontinued if demand drops

or a supplier introduces a new product. Other advantages include the use of competition between suppliers to improve performance in aspects such as price, delivery and quality. However, there can be disadvantages in this arrangement in that either side can end the relationship at any time. A supplier withdrawal requires the often lengthy task of finding a new supplier. From a supplier perspective the withdrawal of a buyer may cause a sudden drop in demand on the operations facility, leading to disruption and idle resources.

Strategic partnerships and alliances When an organisation and supplier are trading successfully they can decide to form a strategic alliance or strategic partnership. This involves a long-term relationship in which organisations work together and share information regarding aspects such as planning systems and the development of products and processes. There may also be agreement on such aspects as product costs and product margins. The idea of a partnership or alliance is to combine the advantages of a marketplace relationship which encourages flexibility and innovation with the advantages of vertical integration which allows close coordination and control of such aspects as quality.

The virtual organisation The implication of e-business developments is that it becomes easier to outsource more and more supply chain activities to third parties and the boundaries between and within organisations become blurred. This development is known as 'virtualisation' and companies that follow this route are known as 'virtual organisations'. The objective is that the absence of any rigid boundary or hierarchy within the organisation should lead to a more responsive and flexible company with greater market orientation.

Vertical integration Complete integration is achieved by an organisation when they take ownership of other organisations in the supply chain. The amount of ownership of the supply chain by an organisation is termed its 'level of vertical integration'. When an organisation owns upstream or supply-side elements of the supply chain it is termed 'backward vertical integration'. Ownership of downstream or demand-side elements of the supply chain is termed 'forward vertical integration'. When a company owns elements of a different supply chain, for example a holding company which has interests in organisations operating in various markets, the term used is 'horizontal integration'.

One potential advantage of vertical integration is the ability to secure a greater control of the competitive environment. Another factor is that

technological innovations in one part of the organisation are available to other elements in the supply chain. Thus product and process improvements can be disseminated quickly. Also improved communication can help coordinate planning and control systems in the supply chain to improve delivery speed and dependability.

There are, however, a number to disadvantages to vertical integration and perhaps the major reason for outsourcing is the cost incurred in owning major elements of the supply chain. The resources required to own elements of the supply chain are resources that cannot be dedicated to the activities that represent the core tasks of an organisation. This means there is a risk in that trying to do everything will mean that a company is not competitive against other companies who are focusing their resources and skills on particular elements of the supply chain. For example, the activity of warehousing may not be a core task for a manufacturer. By outsourcing this function the facilities of a third-party are available who can share storage costs amongst a number of companies and invest in up-to-date warehouse technologies in order to increase efficiency. Another factor is the increased flexibility available when using a number of suppliers to meet fluctuations in demand. This means an organisation only buys the capacity it needs and does not have idle capacity in-house.

Activities in the supply chain

In this section supply chain activities are presented around the areas of procurement which is the operations interface with upstream activities and physical distribution management which deals with downstream activities such as warehousing and transportation.

Procurement

The role of procurement is to acquire all the materials needed by an organisation in the form of purchases, rentals, contracts and other acquisition methods. The procurement process also includes activities such as selecting suppliers, approving orders and receiving goods from suppliers. The term 'purchasing' usually refers to the actual act of buying the raw materials, parts, equipment and all the other goods and services used in operations systems. However the procurement process is often located in what is called the 'purchasing department'.

Procurement is an important aspect of the operations function as the cost of materials can represent a substantial amount of the total cost of a product or service.

Physical Distribution Management

Physical Distribution Management, sometimes called 'business logistics', refers to the movement of materials from the operation to the customer. Four main areas of physical distribution management are materials handling, warehousing, packaging and transportation.

Materials handling Materials handling relates to the movement of materials, either within warehouses or between storages areas and transportation links. The aim of materials handling is to move materials as efficiently as possible. The type of materials handling systems available can be categorised as manual, mechanised and automated.

Warehousing When producing a tangible item it is possible to provide a buffer between supply and demand by holding stock of an item. Many organisations have specific locations to hold this stock, termed a 'warehouse' or 'distribution centre'. Most warehouses are used to hold stock of incoming raw materials used in production or finished goods ready for distribution to customers. Warehouses are also used to store work-in-progress items or spares for equipment. Because of the need to process goods and services through the supply chain as quickly as possible to serve customer demand, warehouses are not simply seen as long-term storage areas for goods, but provide a useful staging post for activities such as sorting, consolidating and packing goods for distribution along the supply chain.

Packaging Packaging provides a number of functions including identifying the product, giving protection during transportation and storage, making handling easier and providing information to customers. The emphasis put on each of these factors will depend on the nature of the product, with protection being a major factor for some products. In terms of packaging materials we have a choice that includes cardboard, plastic, glass, wood and metal. The choice between these is dependent on how they meet the functional needs of the product and their relative cost.

Transportation Distribution is an important element of the supply chain and can account for as much as 20 per cent of the total costs of goods and services. The amount of cost will depend largely on the distance between the company and its customers and the method of transportation chosen. There are five main methods of transportation to choose from: rail, road, air, water and pipeline.

"Evaluate relationships in the supply chain in terms of their degree of integration."

This question requires you to know that organisations in a supply chain can have varying degrees of cooperation and integration and in order of increasing ownership the options are a market relationship, strategic partnerships and alliances, virtual organisation and vertical integration. A short description of each one of these could be followed by some evaluation. For example, at the level of an individual product or service the amount of integration in the supply chain can be characterised as an analysis of the costs and risks in either making a component in-house or buying it from a supplier, termed a 'make-or-buy decision'. However, this approach does not take into account what may be the critical strategic issues involved when deciding what it should do itself and what can be done by others. At a strategic level, supply chain integration decisions should be related to the way that the organisation competes in the marketplace. For example, if speed of delivery is an order winner, then it may be necessary to make certain components in-house to ensure a fast and reliable supply.

"Discuss the importance of procurement."

Start by describing the role of procurement – to acquire all the materials needed by an organisation in the form of purchases, rentals, contracts and other acquisition methods. The procurement process also includes activities such as selecting suppliers, approving orders and receiving goods from suppliers. The term 'purchasing' usually refers to the actual act of buying the raw materials, parts, equipment and all the other goods and services used in operations systems. However, the procurement process is often located in what is called the 'purchasing department'. What makes procurement such an important aspect of the operations

function is that the cost of materials can r epresent a substantial amount of the total cost of a pr oduct or ser vice. Also ther e has r ecently been an enhanced focus on the pr ocurement activity due to the incr eased use of pr ocess technology , both in terms of materials and infor mation pr ocessing. In ter ms of materials pr ocessing, the use of pr ocess technology such as Flexible Manufacturing Systems (FMS) has meant a r eduction in labour costs and thus a fur ther incr ease in the r elative cost of materials associated with a manufactur ed pr oduct. This means that the contr ol of material costs becomes a major focus in the contr ol of overall manufacturing costs for a pr oduct.

Textbook guide

GREASLEY: Chapter 15.
HILL: Chapter 13.
SLACK, CHAMBERS AND JOHNSTON: Chapter 13.

2.18 project management

Projects are unique, one-time operations designed to accomplish a specific set of objectives in a limited time-frame. Examples of projects include a building construction or introducing a new service or product to the market. Large projects may consist of many activities and must therefore be carefully planned and coordinated if a project is to meet cost and time targets.

Not all aspects of implementation can be controlled or planned, but the chance of success can be increased by anticipating potential problems and by applying corrective strategies. Network Analysis can be used to assist the project planning and control activities.

Project management activities

The project management process includes the following main elements of estimating, planning and control.

Project estimating

At the start of the project a broad plan is drawn up assuming unlimited resources. Once estimates have been made of the resources required to undertake these activities it is then possible to compare overall project requirements with available resources. If highly specialised resources are required then the project's completion date may have to be set to ensure these resources are not overloaded. This is a resource-constrained approach. Alternatively there may be a need to complete a project in a specific time-frame (for example due-date specified by a customer). In this case alternative resources may have to be utilised (for example sub-contractors) to ensure timely project completion. This is a time-constrained approach.

The next step is to generate estimates for the time and resources required to undertake each task defined in the project. This information can then be used to plan what resources are required and what activities should be undertaken over the life cycle of the project. Once the activities have been identified and their resource requirements estimated it is necessary to define their relationship to one another. There are some activities that can only begin when other activities have been completed, termed a 'serial relationship'. Other activities may be totally independent and thus they have a parallel relationship.

For a project of a reasonable size there may be a range of alternative plans which may meet the project objectives. Project management software can be used to assist in choosing the most feasible schedule by recalculating resource requirements and timings for each operation.

Project planning

The purpose of the planning stage is to ensure that the project objectives of cost, time and quality are met. It does this by estimating both the level and timing of resources needed over a project's duration. These steps may need to be undertaken repeatedly in a complex project due to uncertainties and to accommodate changes as the project progresses. The planning process does not eradicate the need for the experience of the project manager in anticipating problems or the need for skill in dealing with unforeseen and novel incident during project execution. However, the use of plans which can be executed sensibly will greatly improve the performance of the project.

Project control

Project control involves the monitoring of the project objectives of cost, time and quality as the project progresses. It is important to monitor

and assess performance as the project progresses in order that the project does not deviate from plans to a large extent. Milestones or time events are defined during the project when performance against objectives can be measured. The amount of control will be dependent on the size of the project. Larger projects will require development of control activities from the project leader to team leaders. Computer project management packages can be used to automate the collection of project progress data and production of progress reports.

Network analysis

Network analysis refers to the use of network-based techniques for the analysis and management of projects. Two network analysis techniques are the Critical Path Method (CPM) and the Programme Evaluation and Review Technique (PERT). The main difference between the approaches is the ability of PERT to take into consideration uncertainty in activity durations.

Critical Path Method (CPM)

Critical path diagrams are used extensively to show the activities undertaken during a project and the dependencies between these activities. Thus it is easy to see that Activity C for example can only take place when Activity A and Activity B have been completed. There are two methods of constructing critical path diagrams: Activity on Arrow (AOA) where the arrows represent the activities, and Activity on Node (AON) where the nodes represent the activities.

Once the network diagram has been constructed it is possible to follow a sequence of activities, called a 'path', through the network from start to end. The length of time it takes to follow the path is the sum of all the durations of activities on that path. The path with the longest duration gives the project completion time. This is called the 'critical path' because any change in duration in any activities on this path will cause the whole project duration to either become shorter or longer.

Gantt charts

Although network diagrams are ideal for showing the relationship between project tasks, they do not provide a clear view of which tasks

are being undertaken over time and particularly how many tasks may be undertaken in parallel at any one time. The Gantt chart provides an overview for the project manager to allow them to monitor project progress against planned progress, and so provides a valuable information source for project control.

Project crashing

Within any project there will be a number of time-cost trade-offs to consider. Most projects will have tasks which can be completed with an injection of additional resources, such as equipment or people. Reasons to reduce project completion time include:

- reduction of high indir ect costs associated with equipment
- reduction of new pr oduct development time to market
- avoidance of penalties for late completion
- gaining incentives for early completion
- releasing r esour ces for other pr ojects.

The use of additional resources to reduce project completion time is termed 'crashing the project'. The idea is to reduce overall indirect project costs by increasing direct costs on a particular task. One of most obvious ways of decreasing task duration is to allocate additional labour to a task. This can be either an additional team member or through overtime working.

Project Evaluation and Review Technique (PERT)

The PERT approach attempts to take into account the fact that most task durations are not fixed but vary when they are executed. Thus PERT provides a way of incorporating risk into project schedules. It does this by using a beta probability distribution to describe the variability inherent in the processes. The probabilistic approach involves three time estimates for each activity of 'optimistic time' (the task duration under the most optimistic conditions), 'pessimistic time' (the task duration under the most pessimistic conditions) and 'most likely time' (the most likely task duration).

"Discuss the main elements of the project management process."

This r equires you to identify the main elements of the pr oject management pr ocess as estimating, planning and contr ol and then to pr ovide shor t descriptions o f

each. The estimating stage is when activities are defined and resources needed for them assessed. The planning stage is when you decide how activities are related using a work breakdown structure. Also objectives for completion are defined using the measures of time, budget (cost) and quality. The control stage is when the time, cost and quality measures are monitored and progress is compared to the plan. You would most likely gain more marks if you relate this discussion to a project you are familiar with.

"What assumptions does the network analysis method make?"

This question may well appear as a supplementary part to a question involving the construction of a network diagram. In order to make sensible decisions based on information presented by techniques such as network analysis it is important you understand the assumptions behind the technique. In this case network analysis will assume project activities are independent when in fact the duration of one activity may depend on the duration of another. It will also assume precise breaking points between activities when, however, one activity may begin before another one has finished. Also it should be realised that activities just off the critical path may become critical after it is too late to do anything about them and the activity times used in the network may reflect behavioural issues, for example when estimates that are too short ('blue sky') and too long ('sandbagging') may have been provided.

Textbook guide

GREASLEY: Chapter 16.
HILL: Chapter 10.
SLACK, CHAMBERS AND JOHNSTON: Chapter 16.

2.19 quality

In order to understand programmes such as Total Quality Management (TQM) it is first necessary to consider more closely the meaning of quality itself. If the objective of a business is to produce goods and services that meet customer needs then the concept of quality should be related to how well these needs are met from the customer's point of view.

Feignbaum defines quality around the notion of the combination of product and service characteristics through which the product or service will meet customer expectations. However, since different customers will have different product needs and requirements it follows that they will have different quality expectations.

Garvin defines eight dimensions of quality or quality characteristics which the customer looks for in a product:

- Performance
- Features
- Reliability
- Conformance
- Durability
- Serviceability
- Aesthetics
- Other perceptions.

The customer will trade-off these quality characteristics against the cost of the product in order to get a value-for-money product. From the producers' point of view it is important that marketing can identify customer needs and operations can meet these needs at the quality level expected.

Once the product design has been determined then quality during the production process can be defined by how closely the product meets the specification required by the design. This is termed the 'quality of conformance' and the ability to achieve this depends on a number of factors such as the performance level of the machinery, the materials used, and training of staff in techniques such as statistical process control. In addition the product cost is an important design consideration and the production process needs to produce items at a cost that conforms to the product price.

Thus the organisation must consider quality both from the producer and customer point of view, and product design must take into consideration process design in order that the design specification can be met.

Total Quality Management (TQM)

Total Quality Management (TQM) is a philosophy and approach which aims to ensure that high quality, as defined by the customer, is a primary concern throughout an organisation and all parts of an organisation work towards this goal. TQM does not prescribe a number of steps that must be followed in order to achieve high quality but rather should be considered a framework within which organisations can work. The TQM process will be dependent on factors such as customer needs, employee skills and the current state of quality management within an organisation.

The principles of Total Quality Management

TQM has evolved over a number of years from ideas presented by a number of quality gurus. People like W. Shewhart developed many of the technical methods of statistical control, such as control charts and sampling methods, which formed the basis of quality assurance. In the early 1970s however this technical focus was subsumed by more of a managerial philosophy. A.V. Feigenbaum introduced the concept of Total Quality Control to reflect a commitment of effort on the part of management and employees throughout an organisation to improving quality. There is a particular emphasis on strong leadership to ensure everyone takes responsibility for control and there is also an emphasis on quality improvement as a continual process – giving rise to the term 'continuous improvement'. TQM encompasses both the techniques of quality assurance and the approach of Total Quality Control. A number of implementation models have been put forward by quality gurus such as Deming, Juran and Crosby.

Input from Key Thinkers – The Quality Gurus

If you want to impress someone about your knowledge of quality, name drop some quality gurus into your conversation! Notable gurus include:

(Continued)

(Continued)

W. Edwards Deming – introduced Japanese companies to the Plan-Do-Check-Act (PDCA) cycle as a way of representing the concept of continuous improvement

Philip Crosby – introduced the idea that companies should move towards the goal of zero defects

Armand V. Feigenbaum – developed the idea of Total Quality Control (TQC) and quality at source

Kaoru Ishikawa – credited with the concept of quality circles and suggested the use of fishbone diagrams to identify quality problems

Genichi Taguchi – maintains that products should be designed so that they are robust enough to function satisfactorily despite variations in the production line or in use

The quality-cost trade-off

The classical economic trade-off between costs shows that when the cost of achieving good quality (that is, prevention and appraisal costs) increases, the cost of poor quality (internal and external failure costs) declines. The optimal quality level is thus at the point when quality costs are minimised. However, many Japanese organisations did not accept assumptions behind the traditional model and aimed for a zero defect performance instead. According to the traditional view the costs of prevention rise substantially as the zero defect level is approached. This is based on the assumption that the last errors are the hardest to find and correct. The zero defect approach assumes that it costs no more to remove the last error as the first. It may take longer to determine what the source of the last error is, but the steps to correct it are likely to be simple. While there is debate about the shape of the cost-quality curves and if zero defects is really the lowest cost way to make a product, it is beyond doubt that the new approach to quality performance is beneficial.

Quality standards and awards

ISO 9000 provides a quality standard between suppliers and customers, developed by the International Organisation for Standardisation (see www.iso.ch). Having a predefined quality standard reduces the

complexity of managing a number of different quality standards when a customer has many suppliers. Many countries have adopted ISO 9000 and so it is particularly useful in standardising the relationship between suppliers and customers on a global basis. Other programmes which attempt to provide national and international standards for quality are the European Quality Award (EQA), the EFQM Excellence Model®, the Baldrige Award and the Deming Prize.

Six Sigma Quality

Six Sigma is a quality improvement initiative launched by Motorola in the USA in the 1980s. The initiative was originally conceived by Motorola to achieve quality levels which are within six sigma control limits, corresponding to a rate of 3.4 defective parts per million (PPM). However, 6-sigma has developed beyond a defect elimination program to become a company-wide initiative to reduce costs through process efficiency and increase revenues through process effectiveness.

Statistical Process Control (SPC)

Statistical Process Control (SPC) is a sampling technique which checks the quality of an item which is engaged in a process. Thus SPC should be seen as a quality check for process rather than product design. Quality should be built into the product or service during the design stage and techniques which can assist this are covered in Section 2.9. SPC works by identifying the nature of variations in a process, which are classified as being caused by 'chance' causes or 'assignable' causes.

Chance causes of variation All processes will have some inherent variability due to factors such as ambient temperature, wear of moving parts or slight variations in the composition of the material that is being processed. The technique of SPC involves calculating the limits of these chance-cause variations for a stable system, so any problems with the process can be identified quickly. The limits of the chance-cause variations are called 'control limits' and are shown on a control chart, which also shows sample data of the measured characteristic over time. There are control limits above and below the target value for the measurement, termed the 'upper control limit' (UCL) and 'lower control limit' (LCL) respectively. The behaviour of the process can thus be observed by

studying the control chart. If the sample data plotted on the chart show a random pattern within the upper and lower control limits, then the process is 'in-control'. However, if a sample falls outside the control limits or the plot shows a non-random pattern then the process is 'out-of-control'.

Assignable causes of variation If an 'out-of-control' process is discovered, then it is assumed to have been caused by an assignable cause of variation. This is a variation in the process which is not due to random variation but can be attributed to some change in the process, which needs to be investigated and rectified. However, in some instances the process could actually be working properly and the results could have been caused by sampling error. There are two types of error which can occur when sampling from a population:

- Type I Er ror: an er ror is indicated fr om the sample output when none actually occurs. The pr obability of a Type I er ror is ter med α.
- Type II Er ror: an er ror is occur ring but has not been indicated by the sample output. The pr obability of a Type II er ror is ter med β.

Thus Type I errors may lead to some costly investigation and rectification work which is unnecessary. It may even lead to an unnecessary recall of 'faulty' products. Type II errors will lead to defective products as an out-of-control process goes unnoticed. Customer compensation and loss of sales may result if defective products reach the marketplace. The sampling methodology should ensure that the probability of Type I and Type II errors should be kept as low as is reasonably possible.

Control charts for variable data Control charts for variable data display samples of a measurement that can take a value from a range of possible values. Values will fall in or out of a range around a specified target value. Examples of variable data could be a customer transaction time in a bank or the width of an assembly component. Two control charts are used in measuring variable data. The X Chart shows the distance of sample values from the target value (central tendency) and the R Chart shows the variability of sample values (dispersion).

Control charts for attribute data Attribute control charts measure discrete values such as if a component is defective or not. Thus there are no values, as in a variable control chart, from which a mean and range can be calculated. The data will simply provide a count of how many items

conform to a specification and how many do not. Two control charts will be described for attribute data. The p-chart shows the proportion of defectives in a sample and the c-chart shows the number of defectives in a sample.

Investigating control chart patterns Apart from the plots on the control charts that lie outside the control limits, it is still possible that the process may be out-of-control due to non-random behaviour within the control limits. If the behaviour is random then the plots should follow no discernible pattern and occur either side of the centre line. There are several guidelines for identifying non-random behaviour.

Acceptance sampling

Acceptance sampling consists of taking a random sample from a larger batch or lot of material to be inspected. The quality of the sample is assumed to reflect the overall quality of the lot. If the sample has an unacceptable amount of defects the whole lot will be rejected. The point at which the defect level becomes unacceptable is based on an agreement between the customer and the supplier of the goods. Because acceptance sampling is based on the traditional approach which assumes that a number of defects will be produced by a process, it is usually associated with the receiving inspection process from external suppliers.

"What is the purpose of Total Quality Management (TQM)?"

A good way of appr oaching this question is to define what TQM is and then the purpose will become appar ent. Y ou can define TQM as a philosophy and approach which aims to ensur e that high quality , as defined by the customer , is a primar y concer n thr oughout an or ganisation and all par ts of an or ganisation work towar ds this goal. The main principles of TQM can be summarised as the customer defines quality and thus their needs must be met, quality is the r espon-sibility of all employees in all par ts of an or ganisation and a 'continuous impr ove-ment' cultur e must be developed to instil a cultur e which r ecognises the impor tance of quality to per formance.

"Explain the terms 'chance causes of variation' and 'assignable causes of variation'."

This question may appear as supplementary to a question requiring you to construct a SPC control chart. You can start by saying that Statistical Process Control (SPC) works by identifying the nature of variations in a process, which are classified as being caused by 'chance' causes or 'assignable' causes. Chance-cause variations are defined as the inherent variability due to factors such as ambient temperature, wear of moving parts or slight variations in the composition of a material that is being processed. The technique of SPC involves calculating the limits of these chance-cause variations for a stable system, so any problems with the process can be identified quickly. An assignable cause of variation is a variation in the process which is not due to random variation (namely it is outside the limits defined for chance-cause variations) but is instead attributed to some change in the process, which needs to be investigated and rectified.

Textbook guide

GREASLEY: Chapter 17.
HILL: Chapter 11.
SLACK, CHAMBERS AND JOHNSTON: Chapters 17, 20.

2.20 operations improvement

This section covers topics in operations which you will usually find in textbooks under the heading of Operations Improvement. It should be considered that the focus of Improvement should be directed towards appropriate areas of the operation where any increase in performance will help an organisation meet its strategic goals.

Continuous improvement

Continuous improvement programmes are associated with incremental changes within an organisation whose cumulative effect is to deliver an increased rate of performance improvement. Continuous improvement requires creating the right environment in which the importance of the approach is recognised and rewarded. This means ensuring the involvement of all members of an organisation and ensuring that these members have the problem-solving skills necessary to achieve worthwhile improvements. The issues of environment, involvement and problem-solving skills will now be explored in relation to continuous improvement implementation.

Environment

In order to create the right environment in which improvement can take place, it is important to have a set of procedures for the improvement process which formalises actions so that progress can be monitored and measured. A procedure for an improvement study could follow the steps of the Plan-Do-Check-Act (PDCA) cycle as follows:

1. What changes are needed in order to gain continual improvement?
2. Analyse appropriate data. Carry out suggested changes to the process.
3. Evaluate the results of the changes to the process.
4. Make the changes permanent, or try another step (that is, go to Step 1).

Involvement

The idea behind continuous improvement is to utilise the skills and knowledge of all the workforce in a sustained attempt to improve every aspect of how an organisation operates. It is useful to disseminate information around an organisation regarding progress on various performance measures in order to emphasise the importance of the improvement effort. This can be done using meetings, newsletters and

boards displaying charts. The most common objectives used are the QCDSM measures of Quality, Cost, Delivery, Safety and Morale.

Suggestion schemes

The idea behind suggestion schemes is to offer the person closest to the work activity the opportunity to suggest improvements to the process. Suggestions by employees are evaluated and if they are assessed as providing a significant saving then a cash award may be paid to the employee. The award could be a fixed amount for all suggestions or a percentage of net savings over a specific time period. Suggestion schemes are most likely to be successful when employees are given training in aspects such as data collection and the scheme is promoted, rather than commensurate with the size of any award payments.

Teams for continuous improvement

Process Improvement Teams or Quality Circles are using the different skills and experiences of a group of people in order to solve problems and thus provide a basis for continual improvement. In order to do this a team should be aware of the tools available for measuring and thus improving performance, such as Statistical Process Control (SPC). Expertise outside the group can also be used to contribute to group effectiveness. A Quality Circle is a small group of people who meet voluntarily on a regular basis. Process Improvement Teams are usually made up of experienced problem solvers from departments affected by the process and are appointed by management. The use of a group can be particularly effective at working through a cause and effect diagram to find the root cause of a particular problem.

Problem-solving skills

Information technology has had a particular impact on the level of problem-solving and thus decision-making skills required in an organisation. The decision-making activity is often classified in order that different decision processes and methods can be adopted for the common features of decisions within these choices. Decision types can be classified into strategic, tactical and operational, relating to top, middle and supervisory management levels, with the main variables across these levels being the time-span over which decisions are taken and the

amount of money involved in the choice of option. However, these classifications fail to recognise the changes that are taking place with the introduction of information systems.

The learning organisation

Continuous improvement is associated with the concept of the learning organisation which aims to create an environment that builds knowledge within the organisation and can utilise that to improve performance. The need for organisational learning has been identified as a consequence of the need for organisations to continually produce innovations in order to maintain a competitive edge. The ability to generate a continuous stream of ideas for improvement and implement them is seen as a sustainable competitive advantage for organisations. To consider how an organisation learns is really to consider how the learning of individuals within that organisation takes place and how the results of that learning are integrated into its practices, procedures and processes. The transfer of knowledge from individual to organisational system means that the knowledge becomes independent of the individual, is possessed by the organisation and is replicable by individuals within that organisation.

Business Process Reengineering (BPR)

Business Process Reengineering (BPR) calls for an analysis of a business from a process rather than a functional perspective and a redesign of those processes to optimise performance. When using the technique an organisation should select a process or processes which are critical to it and so provide a potentially large increase in performance in return for the reengineering effort. The scope and number of process redesign projects must be compatible with an organisation's ability and experience to undertake them. The analysis of processes may involve assessing existing business strategy for process direction, consulting with process customers, benchmarking process performance targets and developing process performance objectives and attributes. An understanding of existing processes can be facilitated using techniques such as flow-charting. Key activities in the design and prototype phase are the brainstorming of design activities, assessing the feasibility of

these alternatives, prototyping the new process design, developing a migration strategy and implementing the new organisational structure and systems.

Taking it FURTHER

Continuous improvement programmes are associated with incremental changes within an organisation whose cumulative effect is to deliver an increased rate of performance improvement. The important point about continuous improvement is that it can deliver improvements that are difficult for competitors to copy. For instance, a culture which recognises and delivers quality and reliability is a long-term project which may not show immediate financial benefit. However, in order to catch up or overtake competitors it has been realised that continuous improvements alone may not be enough, but that step changes in performance are also required. These are associated with innovations in areas such as product design or process design. The technique of Business Process Reengineering (BPR) has been widely cited as an approach which locates suitable areas for change and delivers improvements to them.

Balanced scorecard

Linked to the topic of operations improvement is the area of performance measurement which involves choosing the measures which will be used to determine if improvement has taken place. Traditionally, performance measures in operations have focused on indicators such as productivity which divides the value of the output by the value of the input resources consumed. The balanced scorecard approach is an attempt to incorporate the interests of a broader range of stakeholders through performance measures across four perspectives: financial, stakeholder/customer, business process and innovation and learning. The idea of the scorecard is to provide managers with a multiple perspective of the goals that need to be met for organisational success. In operations management the five performance objectives (see Section 2.3) of quality, dependability, speed, flexibility and cost are intended to provide a more customer-based and strategic perspective to performance measurement.

Benchmarking

Benchmarking can be defined as the continuous measurement of an organisation's products and processes against a company recognised as a leader in that industry. Benchmarking was initially restricted to the comparison of direct competitors in the manufacturing sector. Now it is practised in the service sector (for example banks), in all functional areas (for example marketing) and in comparison with a wide variety of competitors from which lessons can be learnt (that is, not just the best-in-class). Because of the widespread use of the technique and requests by many organisations to visit the same high performance firms, much benchmarking data is held in databases for general use.

"Discuss how continuous improvement and business process reengineering improvement approaches can coexist."

Start by defining each concept and then show how what seem at first to be radically different approaches can coexist. Continuous improvement can be defined as a programme that is associated with incremental changes within an organisation whose cumulative effect is to deliver an increased rate of performance improvement. The important point about continuous improvement is that it can deliver improvements that are difficult for competitors to copy. The technique of Business Process Reengineering (BPR) has been widely cited as an approach which locates suitable areas for change and delivers improvements to them. In terms of coexistence the two approaches share an orientation to process as the unit of improvement, an orientation to strategy execution rather than the strategy itself, a belief in the importance of measurement and analysis and a focus on external criteria (for example benchmarking) as the basis for judging improvement.

Textbook guide

GREASLEY: Chapter 18.
HILL: Chapters 3, 16.
SLACK, CHAMBERS AND JOHNSTON: Chapter 18.

part three

study, writing and revision skills*

General introduction

If you work your way carefully through this Part you should at the end be better equipped to profit from your lectures, benefit from your seminars, construct your essays efficiently, develop effective revision strategies and respond comprehensively to the pressures of exam situations. In the five sections that lie ahead you will be presented with: checklists and bullet points to focus your attention on key issues; exercises to help you participate actively in the learning experience; illustrations and analogies to enable you to anchor learning principles in everyday events and experiences; worked examples to demonstrate the use of such features as structure, headings and continuity; tips that provide practical advice in nutshell form.

In the exercises that are presented each student should decide how much effort they would like to invest in each exercise, according to individual preferences and requirements. Some of the points in the exercises will be covered in the text either before or after the exercise. You might prefer to read each section right through before going back to tackle the exercises. Suggested answers are provided in italics after some of the exercises, so avoid these if you prefer to work through the exercises on your own. The aim is to prompt you to reflect on the material, remember what you have read and trigger you to add your own thoughts. Space is provided for you to write your responses down in a few words, or you may prefer to reflect on them within your own mind. However, writing will help you to slow down and digest the material and may also enable you to process the information at a deeper level of learning.

Finally the overall aim of the Part is to point you towards the keys for academic and personal development. The twin emphases of academic development and personal qualities are stressed throughout. By giving attention to these factors you will give yourself the toolkit you will need to excel in your studies.

*in collaboration with David McIlroy

3.1 how to get the most out of your lectures

This section will show you how to:

- Make the most of your lectur e notes.
- Prepare your mind for new ter ms.
- Develop an independent appr oach to lear ning.
- Write ef ficient summar y notes fr om lectur es.
- Take the initiative in building on your lectur es.

Keeping in context

According to higher educational commentators and advisors, best quality learning is facilitated when it is set within an overall learning context. It should be the responsibility of your tutors to provide a context for you to learn in, but it is your responsibility to see the overall context, and you can do this even before your first lecture begins. Such a panoramic view can be achieved by becoming familiar with the outline content of both a given subject and the entire study programme. Before you go into each lecture you should briefly remind yourself of where it fits into the overall scheme of things. Think, for example, of how more confident you feel when you move into a new city (for example to attend university) once you become familiar with your bearings – that is, where you live in relation to college, shops, stores, buses, trains, places of entertainment and so on.

The same principle applies to your course – find your way around your study programme and locate the position of each lecture within this overall framework.

Use of lecture notes

It is always beneficial to do some preliminary reading before you enter a lecture. If lecture notes are provided in advance (for example, electronically),

then print these out, read over them and bring them with you to the lecture. You can insert question marks on issues where you will need further clarification. Some lecturers prefer to provide full notes, some prefer to make skeleton outlines available and some prefer to issue no notes at all! If notes are provided, take full advantage and supplement these with your own notes as you listen. In a later section on memory techniques you will see that humans possess the ability for 're-learning savings' – namely it is easier to learn material the second time round, as it is evident that we have a capacity to hold residual memory deposits. So some basic preparation will equip you with a great advantage – you will be able to 'tune in' and think more clearly about the lecture than you would have done without this preliminary work.

If you set yourself too many tedious tasks at the early stages of your academic programme you may lose some motivation and momentum. A series of short, simple, achievable tasks can give your mind the 'lubrication' you need. For example, you are more likely to maintain preliminary reading for a lecture if you set modest targets.

Mastering technical terms

Let us assume that in an early lecture you are introduced to a series of new terms such as 'paradigm', 'empirical' and 'zeitgeist'. If you are hearing these and other terms for the first time, you could end up with a headache! New words can be threatening, especially if you have to face a string of them in one lecture. The uncertainty about the new terms may impair your ability to benefit fully from the lecture and therefore hinder the quality of your learning. Some subjects require technical terms and the use of them is unavoidable. However, when you have heard a term a number of times it will not seem as daunting as it initially was. It is claimed that individuals may have particular strengths in the scope of their vocabulary. Some people may have a good recognition vocabulary – they immediately know what a word means when they read it or hear it in context. Others have a good command of language when they speak – they have an ability to recall words freely. Still others are more fluent in recall when they write – words seem to flow rapidly for them when they engage in the dynamics of writing. You can work at developing all three approaches in your course, and the checklist below may be of some help in mastering and marshalling the terms you hear in lectures.

In terms of learning new words, it will be very useful if you can first try to work out what they mean from their context when you first encounter them. You might be much better at this than you imagine especially if there is only one word in the sentence that you do not understand. It would also be very useful if you could obtain a small indexed notebook and use this to build up your own glossary of terms. In this way you could include a definition of a word, an example of its use, where it fits into a theory and any practical application of it.

Checklist for mastering terms used in your lectures:

- ✓ Read lectur e notes befor e the lectur es and list any unfamiliar ter ms.
- ✓ Read over the listed ter ms until you ar e familiar with their sound.
- ✓ Try to work out meanings of ter ms fr om their context.
- ✓ Do not suspend lear ning the meaning of a ter m indefinitely.
- ✓ Write out a sentence that includes the new wor d (do this for each wor d).
- ✓ Meet with other students and test each other with the technical ter ms.
- ✓ Jot down new wor ds you hear in lectur es and check out the meaning soon after wards.

Your confidence will greatly increase when you begin to follow the flow of arguments that contain technical terms, and more especially when you can freely use the terms yourself in speaking and writing.

Developing independent study

In the current educational ethos there are the twin aims of cultivating teamwork/group activities and independent learning. There is not necessarily a conflict between the two, as they should complement each other. For example, if you are committed to independent learning you have more to offer other students when you work in small groups, and you will also be prompted to follow up on the leads given by them. Furthermore, the guidelines given to you in lectures are designed to lead you into deeper independent study. The issues raised in lectures are pointers to provide direction and structure for your extended personal pursuit. Your aim should invariably be to build on what you are given, and you should never think of merely returning the bare bones of the lecture material in a coursework essay or exam.

It is always very refreshing to a marker to be given work from a student that contains recent studies that the examiner had not previously encountered.

Note taking strategy

Note taking in lectures is an art that you will only perfect with practice and by trial and error. Each student should find the formula that works best for him or her. What works for one, does not work for the other. Some students can write more quickly than others, some are better at shorthand than others and some are better at deciphering their own scrawl! The problem will always be to try to find a balance between concentrating beneficially on what you hear, with making sufficient notes that will enable you to comprehend later what you have heard. You should not, however, become frustrated by the fact that you will not understand or remember immediately everything you have heard.

By being present at a lecture, and by making some attempt to attend to what you hear, you will already have a substantial advantage over those students who do not attend.

Guidelines for note taking in lectures

- Develop the note taking strategy that works best for you.
- Work at finding a balance between listening and writing.
- Make some use of optimal shor thand (for example, a few key wor ds may summarise a stor y).
- Too much writing may impair the flow of the lectur e for you.
- Too much writing may impair the quality of your notes.
- Some limited notes ar e better than none.
- Good note taking may facilitate deeper pr ocessing of infor mation.
- It is essential to 'tidy up' notes as soon as possible after a lectur e.
- Reading over notes soon after lectur es will consolidate your lear ning.

Developing the lecture

Some educationalists have criticised the value of lectures because they allege that these are a mode of merely 'passive learning'. This can certainly

be an accurate conclusion to arrive at (that is, if students approach lectures in the wrong way) and lecturers can work to devise ways of making lectures more interactive. For example, they can make use of interactive handouts or by posing questions during the lecture and giving time out for students to reflect on these. Other possibilities are short discussions at given junctures in the lecture or use of small groups within the session. As a student you do not have to enter a lecture in passive mode and you can ensure that you are not merely a passive recipient of information by taking steps to develop the lecture yourself. A list of suggestions is presented below to help you take the initiative in developing the lecture content.

Checklist to ensure that the lecture is not merely a passive experience:

- ✓ Try to interact with the lectur e material by asking questions.
- ✓ Highlight points that you would like to develop in personal study .
- ✓ Trace connections between the lectur e and other par ts of your study pr ogramme.
- ✓ Bring together notes fr om the lectur e and other sour ces.
- ✓ Restr ucture the lectur e outline into your own pr eferred for mat.
- ✓ Think of ways in which aspects of the lectur e material can be applied.
- ✓ Design ways in which aspects of the lectur e material can be illustrated.
- ✓ If the lectur er invites questions, make a note of all the questions asked.
- ✓ Follow up on issues of inter est that have arisen out of the lectur e.

You can contribute to this active involvement in a lecture by engaging with the material before, during and after it is delivered.

EXERCISE

You might now like to attempt to summarise (and/or add) some factors that would help you to capitalise fully on the benefits of a lecture.

- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....

3.2

how to make the most of seminars

This section will show you how to:

- Be aware of the value of seminars.
- Focus on links to learning.
- Recognise qualities you can use repeatedly.
- Manage potential problems in seminars.
- Prepare yourself adequately for seminars.

Not to be underestimated

Seminars are often optional in a degree programme and sometimes poorly attended because they are underestimated. Some students may be convinced that the lecture is the truly authoritative way to receive quality information. Undoubtedly, lectures play an important role in an academic programme, but seminars have a unique contribution to learning that will complement lectures. Other students may feel that their time would be better spent in personal study. Again, private study is unquestionably essential for personal learning and development, but you will nevertheless diminish your learning experience if you neglect seminars. If seminars were to be removed from academic programmes, then something really important would be lost.

Checklist – some useful features of seminars:

- ✓ Can identify problems that you had not thought of.
- ✓ Can clear up confusing issues.
- ✓ Allows you to ask questions and make comments.
- ✓ Can help you develop friendships and teamwork.
- ✓ Enables you to refresh and consolidate your knowledge.
- ✓ Can help you sharpen motivation and redirect study efforts.

An asset to complement other learning activities

In higher education at the present time there is emphasis on variety – variety in delivery, learning experience, learning styles and assessment methods. The seminar is deemed to hold an important place within the overall scheme of teaching, learning and assessment. In some programmes the seminars are directly linked to the assessment task. Whether or not they have such a place in your course, they will provide you with a unique opportunity to learn and develop.

In a seminar you will hear a variety of contributions, and different perspectives and emphases. You will have the chance to interrupt and undergo the experience of being interrupted! You will also learn that you can get things wrong and still survive! It is often the case that when one student admits that they did not know some important piece of information, other students quickly follow on to the same admission in the wake of this. If you can learn to ask questions and not feel stupid, then seminars will give you an asset for learning and a life-long educational quality.

Creating the right climate in seminars

It has been said that we have been given only one mouth to talk with, but two ears to listen with. One potential problem with seminars is that some students may take a while to learn this lesson, and other students may have to help hasten them on the way (graciously but firmly!). In lectures your main role is to listen and take notes, but in seminars there is the challenge to strike the balance between listening and speaking. It is important to make a beginning in speaking even if it is just to repeat something that you agree with. You can also learn to disagree in an agreeable way. For example, you can raise a question against what someone else has said and pose this in a good tone – for example, 'If that is the case, does that not mean that …'. In addition it is perfectly possible to disagree with others by avoiding personal attacks, such as, 'that was a really stupid thing to say', or 'I thought you knew better than that', or 'I'm surprised that you don't know that by now'. Educationalists say that it is important to have the right climate to learn in, and the avoidance of unnecessary conflict will foster such a climate.

EXERCISE

Suggest what can be done to reach agreement (set ground rules) that would help keep seminars running smoothly and harmoniously.

✓ .....

✓ .....

✓ .....

✓ .....

✓ .....

Some suggestions are: appoint someone to guide and control the discussion; invite individuals to prepare in advance to make a contribution; hand out agreed discussion questions at some point prior to the seminar; stress at the beginning that no one should monopolise the discussion and emphasise that there must be no personal attacks on any individual (state clearly what this means). Also you could invite and encourage quieter students to participate and assure each person that their contribution is valued.

Links in learning and transferable skills

An important principle in learning to progress from shallow to deep learning is developing the capacity to make connecting links between themes or topics and across subjects. This also applies to the various learning activities such as lectures, seminars, fieldwork, computer searches and private study. Another factor to think about is, 'what skills can I develop, or improve on, from seminars that I can use across my study programme?' A couple of examples of key skills are the ability to communicate and the capacity to work within a team. These are skills that you will be able to use at various points in your course (transferable), but you are not likely to develop them within the formal setting of a lecture.

EXERCISE

Write out or think about (a) three things that give seminars value, and, (b) three useful skills that you can develop in seminars.

(a)

✓ .....

✓ .....

✓ .....

(b)

- ✓ .....
- ✓ .....
- ✓ .....

In the above exercises, for (a) you could have – variety of contributors, flexibility to spend more time on problematic issues and agreed agenda settled at the beginning of the seminar. For (b) you could have, communication, conflict resolution and team work.

A key question that you should bring to every seminar – 'How does this seminar connect with my other learning activities and my assessments?'

An opportunity to contribute

If you have never made a contribution to a seminar before, you may need something to use as an 'ice breaker'. It does not matter if your first contribution is only a sentence or two – the important thing is to make a start. One way to do this is to make brief notes as others contribute, and whilst doing this, a question or two might arise in your mind. If your first contribution is a question, that is a good start. Or it may be that you will be able to point out some connection between what others have said, or identify conflicting opinions that need to be resolved. If you have already begun making contributions, it is important that you keep the momentum going, and do not allow yourself to lapse back into the safe cocoon of shyness.

EXERCISE

See if you can suggest how you might resolve some of the following problems that might hinder you from making a contribution to seminars.

One student who dominates and monopolises the discussion.

- ✓ .....
- ✓ .....

Someone else has already said what you really want to say.

✓ .....

✓ .....

Fear that someone else will correct you and make you feel stupid.

✓ .....

✓ .....

Feel that your contribution might be seen as short and shallow.

✓ .....

✓ .....

A previous negative experience puts you off making any more contributions.

✓ .....

✓ .....

Strategies for benefiting from your seminar experience

If you are required to bring a presentation to your seminar, you might want to consult a full chapter on presentations in a complementary study guide (McIllroy, 2003). Alternatively, you may be content with the summary bullet points presented at the end of this section. In order to benefit from discussions in seminars (the focus of this section), some useful summary nutshells are now presented as a checklist.

Checklist – how to benefit from seminars:

- ✓ Do some pr eparator y reading.
- ✓ Familiarise yourself with the main ideas to be addr essed.
- ✓ Make notes during the seminar .
- ✓ Make some verbal contribution, even a question.
- ✓ Remind yourself of the skills you can develop.
- ✓ Trace lear ning links fr om the seminar to other subjects/topics on your programme.
- ✓ Make brief bullet points on what you should follow up on.

- ✓ Read over your notes as soon as possible after the seminar .
- ✓ Continue discussion with fellow students after the seminar has ended.

If required to give a presentation:

- Have a practice r un with friends.
- If using visuals, do not obstr uct them.
- Check out befor ehand that all equipment works.
- Space out points clearly on visuals (lar ge and legible).
- Time talk by visuals (for example, 5 slides by 15 minute talk = 3 minutes per slide).
- Make sur e your talk synchr onises with the slide on view at any given point.
- Project your voice so that all in the r oom can hear .
- Inflect your voice and do not stand motionless.
- Spread eye contact ar ound the audience.
- Avoid twin extr emes of a fixed gaze at individuals, and never looking at anyone.
- Better to fall a little shor t of time allocation as r un over it.
- Be selective in what you choose to pr esent.
- Map out wher e you ar e going and summarise main points at the end.

3.3

essay writing tips

This section will show you how to:

- Quickly engage with the main ar guments.
- Channel your passions constr uctively.
- Note your main ar guments in an outline.
- Find and focus on your central topic questions.
- Weave quotations into your essay .

Getting into the flow

In essay writing one of your first aims should be to get your mind active and engaged with your subject. Tennis players like to go out on court

and hit the ball back and forth just before the competitive match begins. This allows them to judge the bounce of the ball, feel its weight against their racket, get used to the height of the net, the parameters of the court and other factors such as temperature, light, sun and the crowd. In the same way you can 'warm up' for your essay by tossing the ideas to and fro within your head before you begin to write. This will allow you to think within the framework of your topic, and this will be especially important if you are coming to the subject for the first time.

The tributary principle

A tributary is a stream that runs into a main river as it wends its way to the sea. Similarly in an essay you should ensure that every idea you introduce is moving toward the overall theme you are addressing. Your idea might of course be relevant to a subheading that is in turn relevant to a main heading. Every idea you introduce is to be a 'feeder' into the flowing theme. In addition to tributaries, there can also be 'distributaries', which are streams that flow away from the river. In an essay these would represent the ideas that run away from the main stream of thought and leave the reader trying to work out what their relevance may have been. It is one thing to have grasped your subject thoroughly, but quite another to convince your reader that this is the case. Your aim should be to build up ideas sentence-by-sentence and paragraph-by-paragraph, until you have communicated your clear purpose to the reader.

It is important in essay writing that you do not only include material that is relevant, but that you also make the linking statements that show the connection to the reader.

Listing and linking the key concepts

All subjects will have central concepts that can sometimes be usefully labelled by a single word. Course textbooks may include a glossary of terms and these provide a direct route to the beginning of efficient mastery of the topic. The central words or terms are the essential raw materials that you will need to build upon. Ensure that you learn the words and their definitions, and that you can go on to link the key words together so that in your learning activities you will add understanding to your basic memory work.

It is useful to list your key words under general headings if that is possible and logical. You may not always see the connections immediately but when you later come back to a problem that seemed intractable, you will often find that your thinking is much clearer.

EXAMPLE Write an essay on 'Aspects and perceptions of ageing'.

You might decide to draft your outline points in the following manner (or you may prefer to use a mind map appr oach):

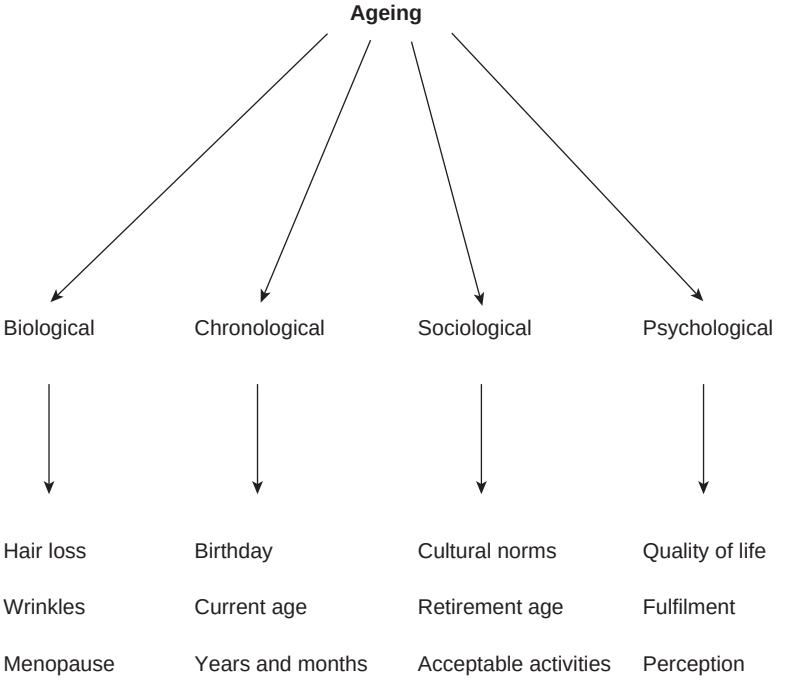


Figure 3.1 A mind map

An adversarial system

In higher education students are required to make the transition from descriptive to critical writing. If you can think of the critical approach

like a law case that is being conducted where there is both a prosecution and a defence, your concern should be for objectivity, transparency and fairness. No matter how passionately you may feel about a given cause you must not allow information to be filtered out because of your personal prejudice. An essay is not to become a crusade for a cause in which the contrary arguments are not addressed in an even-handed manner. This means that you should show awareness that opposite views are held and you should at least represent these as accurately as possible.

Your role as the writer is like that of the judge in that you must ensure that all the evidence is heard, and that nothing will compromise either party.

Stirring up passions

The above points do not of course mean that you are not entitled to a personal persuasion or to feel passionately about your subject. On the contrary such feelings may well be a marked advantage if you can bring them under control and channel them into balanced, effective writing (see the example below). Some students may be struggling at the other end of the spectrum – being required to write about a topic that they feel quite indifferent about. As you engage with your topic and toss the ideas around in your mind, you will hopefully find that your interest is stimulated, if only at an intellectual level initially. How strongly you feel about a topic, or how much you are interested in it, may depend on whether you choose the topic yourself or whether it has been given to you as an obligatory assignment.

It is important that in a large project (such as a dissertation) that you choose a topic for which you can maintain your motivation, momentum and enthusiasm.

EXAMPLE An issue that may stir up passions: Arguments for and against the existence of God

For

- Universe appears to have a design.
- Humans have an innate desir e to worship.
- Humans ar e fr ee to choose good or evil.
- Common thr eads between r eligions.
- Religion pr ovides str ong moral foundations.

- Individuals report subjective experiences.
- God's revelation is in holy books.

Against

- There are flaws in the universe.
- Not all appear to have the desire to worship.
- How can evil be adequately explained?
- Many religions and diverse beliefs.
- Humanists accept moral principles.
- Subjective experiences not infallible.
- Devout people differ in interpretation.

Structuring an outline

Whenever you sense a flow of inspiration to write on a given subject, it is essential that you put this into a structure that will allow your inspiration to be communicated clearly. It is a basic principle in all walks of life that structure and order facilitate good communication. Therefore, when you have the flow of inspiration in your essay you must get this into a structure that will allow the marker to recognise the true quality of your work. For example you might plan for an introduction, conclusion, three main headings and each of these with several subheadings (see the example below). Moreover, you may decide not to include your headings in your final presentation – that is, just use them initially to structure and balance your arguments. Once you have drafted this outline you can then easily sketch an introduction, and you will have been well prepared for the conclusion when you arrive at that point.

A good structure will help you to balance the weight of each of your arguments against each other, and arrange your points in the order that will facilitate the fluent progression of your argument.

EXAMPLE Write an essay that assesses the dynamics of the housing market in the decision to purchase or delay.

1 The quest to be on the property ladder.

(a) A house is an investment.

(b) Rent payments are a 'black hole' for money.

(c) Insufficient quantity of houses for growing needs.
(d) Social pressure to be a homeowner.

2 Compounded problems for first time buyers.

(a) Delay in purchase to save deposit.
(b) Ratio balance of salary against mortgage.
(c) Balancing mortgage costs with preferred life-style.
(d) Balancing the choice of house with the choice of area.

3 The problem of inflationary pressures.

(a) Uncertainty of interest rates and world economies.
(b) Income may fall behind inflation.
(c) Future house price slumps could create negative equity.
(d) Conflicting reports in economic forecasts.

Finding major questions

When you are constructing a draft outline for an essay or project, you should ask what is the major question or questions you wish to address. It would be useful to make a list of all the issues that spring to mind that you might wish to tackle. The ability to design a good question is an art form that should be cultivated, and such questions will allow you to impress your assessor with the quality of your thinking.

If you construct your ideas around key questions, this will help you focus your mind and engage effectively with your subject. Your role will be like that of a detective – exploring the evidence and investigating the findings.

To illustrate the point, consider the example presented below. If you were asked to write an essay about the effectiveness of the police in your local community you might as your starting point pose the following questions.

EXAMPLE The effectiveness of the police in the local community: initial questions.

- Is there a high profile police presence?
- Are there regular 'on the beat' officers and patrol car activities?

- Do recent statistics show increases or decreases in crime in the area?
- Are the police involved in community activities and local schools?
- Does the local community welcome and support the police?
- Do the police have a good reputation for responding to calls?
- Do the police harass people unnecessarily?
- Do minority groups perceive the police as fair?
- Do the police have an effective complaints procedure to deal with grievances against them?
- Do the police solicit and respond to local community concerns?

Rest your case

It should be your aim to give the clear impression that your arguments are not based entirely on hunches, bias, feelings or intuition. In exams and essay questions it is usually assumed (even if not directly specified) that you will appeal to evidence to support your claims. Therefore, when you write your essay you should ensure that it is liberally sprinkled with citations and evidence. By the time the assessor reaches the end of your work, he or she should be convinced that your conclusions are evidence based. A fatal flaw to be avoided is to make claims for which you have provided no authoritative source.

Give the clear impression that what you have asserted is derived from recognised sources (including up-to-date). It also looks impressive if you spread your citations across your essay rather than compressing them into a paragraph or two at the beginning and end.

Some examples of how you might introduce your evidence and sources are provided below:

According to O'Neil (1999) ...

Wilson (2003) has concluded that ...

Taylor (2004) found that ...

It has been claimed by McKibben (2002) that ...

Appleby (2001) asserted that ...

A review of the evidence by Lawlor (2004) suggests that ...

Findings from a meta-analysis presented by Rea (2003) would indicate that ...

It is sensible to vary the expression used so that you are not monotonous and repetitive, and it also aids variety to introduce researchers names at various places in the sentence (not always at the beginning). It is advisable to choose the expression that is most appropriate – for example you can make a stronger statement about reviews that have identified recurrent and predominant trends in findings as opposed to one study that appears to run contrary to all the rest.

Credit is given for the use of caution and discretion when these are clearly needed.

Careful use of quotations

Although it is desirable to present a good range of cited sources, it is not judicious to present these as a 'patchwork quilt' – that is, you just paste together what others have said with little thought for interpretative comment or coherent structure. It is a good general point to aim to avoid very lengthy quotes – short ones can be very effective. Aim at blending the quotations as naturally as possible into the flow of your sentences. Also it is good to vary your practices – sometimes use short, direct, brief quotes (cite page number as well as author and year), and at times you can summarise the gist of a quote in your own words. In this case you should cite the author's name and year of publication but leave out quotation marks and page number.

Use your quotes and evidence in a manner that demonstrates that you have thought the issues through, and have integrated them in a manner that shows you have been focused and selective in the use of your sources.

In terms of referencing, practice may vary from one discipline to the next, but some general points that will go a long way in contributing to good practice are:

- If a r eference is cited in the text, it must be in the list at the end (and vice versa).

- Names and dates in the text should cor respond exactly with the list in the references or bibliography .
- The list of r eferences or bibliography should be in alphabetical or der by the surname (not the initials) of the author or first author .
- Any r eference you make in the text should be traceable by the r eader (they should clearly be able to identify and trace the sour ce).

A clearly defined introduction

In an introduction to an essay you have the opportunity to define the problem or issue that is being addressed and to set it within context. Resist the temptation to elaborate on any issue at the introductory stage. For example, think of a music composer who throws out hints and suggestions of the motifs that the orchestra will later develop. What he or she does in the introduction is to provide little tasters of what will follow in order to whet the audience's appetite. If you go back to the analogy of the game of tennis, you can think of the introduction as marking out the boundaries of the court in which the game is to be played.

If you leave the introduction and definition of your problem until the end of your writing, you will be better placed to map out the directions that will be taken.

EXERCISE

An example for practice, if you wish, can be engaged if you look back at the drafted outline on assessing the dynamics of the housing market. Try to design an introduction for that essay in about three or four sentences.

Conclusion – adding the finishing touches

In the conclusion you should aim to tie your essay together in a clear and coherent manner. It is your last chance to leave an overall impression in your reader's mind. Therefore, you will at this stage want to do justice to your efforts and not sell yourself short. This is your opportunity to identify where the strongest evidence points or where the balance of probability

lies. The conclusion to an exam question often has to be written hurriedly under the pressure of time, but with an essay (coursework) you have time to reflect on, refine and adjust the content to your satisfaction. It should be your goal to make the conclusion a smooth finish that does justice to the range of content in summary and succinct form. Do not underestimate the value of an effective conclusion. 'Sign off' your essay in a manner that brings closure to the treatment of your subject.

The conclusion facilitates the chance to demonstrate where the findings have brought us to date, to highlight the issues that remain unresolved and to point to where future research should take us.

Top-down and bottom-up clarity

An essay gives you the opportunity to refine each sentence and paragraph on your word processor. Each sentence is like a tributary that leads into the stream of the paragraph that in turn leads into the mainstream of the essay. From a 'top down' perspective (that is, starting at the top with your major outline points), clarity is facilitated by the structure you draft in your outline. You can ensure that the subheadings are appropriately placed under the most relevant main heading, and that both sub and main headings are arranged in a logical sequence. From a 'bottom up' perspective (that is, building up the details that 'flesh out' your main points), you should check that each sentence is a 'feeder' for the predominant concept in a given paragraph. When all this is done you can check that the transition from one point to the next is smooth rather than abrupt.

Checklist – summary for essay writing:

- ✓ Before you star t – have a 'war m up' by tossing the issues ar ound in your head.
- ✓ List the major concepts and link them in fluent for m.
- ✓ Design a str ucture (outline) that will facilitate balance, pr ogression, fluency and clarity.
- ✓ Pose questions and addr ess these in critical fashion.
- ✓ Demonstrate that your ar guments r est on evidence and spr ead cited sour ces across your essay .

- ✓ Provide an intr oduction that sets the scene and a conclusion that r ounds of f the ar guments.

EXERCISE

Attempt to write (or at least think about) some additional features that would help facilitate good essay writing.

- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....

In the above checklist you could have features such as originality, clarity in sentence and paragraph structure, applied aspects, addressing a subject you feel passionately about and the ability to avoid going off at a tangent.

3.4

revision hints and tips

This section will show you how to:

- Map out your accumulated material for r evision.
- Choose summar y tags to guide your r evision.
- Keep well-or ganised folders for r evision.
- Make use of ef fective memor y techniques.
- Revise combining bullet points and in-depth r eading.
- Profit fr om the benefits of r evising with others.
- Attend to the practical exam details that will help keep panic at bay .

- Use strategies that keep you task-focused during the exam.
- Select and apply r elevant points fr om your pr epared outlines.

The return journey

In a return journey you will usually pass by all the same places that you had already passed when you were outward bound. If you had observed the various landmarks on you outward journey you would be likely to remember them on your return. Similarly, revision is a means to 'revisit' what you have encountered before. Familiarity with your material can help reduce anxiety, inspire confidence and fuel motivation for further learning and good performance.

If you are to capitalise on your revision period, then you must have your materials arranged and at hand for the time when you are ready to make your 'return journey' through your notes.

Start at the beginning

A strategy for revision should be on your mind from your first lecture at the beginning of your academic semester. You should be like the squirrel that stores up nuts for the winter. Do not waste any lecture, tutorial, seminar, group discussion, and so on by letting the material evaporate into thin air. Get into the habit of making a few guidelines for revision after each learning activity. Keep a folder, or file, or little notebook that is reserved for revision and write out the major points that you have learned. By establishing this regular practice you will find that what you have learned becomes consolidated in your mind, and you will also be in a better position to 'import' and 'export' your material both within and across subjects.

If you do this regularly, and do not make the task too tedious, you will be amazed at how much useful summary material you have accumulated when revision time comes.

Compile summary notes

It would be useful and convenient to have a little notebook or cards on which you can write outline summaries that provide you with an overview of your subject at a glance. You could also use treasury tags to hold different batches of cards together whilst still allowing for inserts and re-sorting. Such practical resources can easily be slipped into your pocket or bag and produced when you are on the bus or train or whilst sitting in a traffic jam. They would also be useful if you are standing in a queue or waiting for someone who is not in a rush! A glance over your notes will consolidate your learning and will also activate your mind to think further about your subject. Therefore it would also be useful to make a note of the questions that you would like to think about in greater depth. Your primary task is to get into the habit of constructing outline notes that will be useful for revision, and a worked example is provided below.

There is a part of the mind that will continue to work on problems when you have moved on to focus on other issues. Therefore, if you feed on useful, targeted information, your mind will continue to work on 'automatic pilot' after you have 'switched off'.

EXAMPLE Part of a course on communication is the use of non-verbal communication, and your outline revision structure for this might be as follows.

1 Aspects of non-verbal communication that r un parallel with language:

- Pauses.
- Tone of voice.
- Inflection of voice.
- Speed of voice.

2 Facets of non-verbal communication r elated to use of body par ts:

- How close to stand to others.
- How much to use the hands.
- Whether to make physical contact – for example touching, hugging, handshake.
- Extent and fr equency of eye contact.

3 General features that augment communication:

- Use of smiles and frowns.
- Use of eyebrows.
- Expressions of boredom or interest.
- Dress and appearance.

Keep organised records

People who have a fulfilled career have usually developed the twin skills of time and task management. It is worth pausing to remember that you can use your academic training to prepare for your future career in this respect. Therefore, ensure that you do not fall short of your potential because these qualities have not been cultivated. One important tactic is to keep a folder for each subject and divide this topic-by-topic. You can keep your topics in the same order in which they are presented in your course lectures. Bind them together in a ring binder or folder and use subject dividers to keep them apart. Make a numbered list of the contents at the beginning of the folder, and list each topic clearly as it marks a new section in your folder. Another important practice is to place all your notes on a given topic within the appropriate section and don't put off this simple task, do it straightaway. Notes may come from lectures, seminars, tutorials, internet searches, personal notes, and so on. It is also essential that when you remove these for consultation that you return them to their 'home' immediately after use.

Academic success has as much to do with good organisation and planning, as it has to do with ability. The value of the quality material you have accumulated on your academic programme may be diminished because you have not organised it into an easily retrievable form.

EXAMPLE Fun example of an organised record – a history of romantic relationships.

- Physical features my girlfriends/boyfriends have shared or differed in.
- Common and diverse personality characteristics.
- Shared and contrasting interests.

- Frequency of dates with each.
- Places fr equented together .
- Contact with both cir cles of friends.
- Use of humour in our communication.
- Frequency and r esolution of conflicts.
- Mutual gener osity.
- Cour tesy and consideration.
- Punctuality.
- Dress and appearance.

Let's imagine that you had five girlfriends/boyfriends over the last few years. Each of the five names could be included under all of the above subjects. You could then compare them with each other – looking at what they had in common and how they differed. Moreover, you could think of the ones you liked best and least, and then look through your dossier to establish why this might have been. You could also judge who had most and least in common with you and whether you are more attracted to those who differed most from you. The questions open to you can go on and on. The real point here is that you will have gathered a wide variety of material that is organised in such a way that it will allow you to use a range of evidence to come up with some satisfactory and authoritative conclusions – if that is possible in matters so directly related to the heart!

Use past papers

Revision will be very limited if it is confined to memory work. You should by all means read over your revision cards or notebook and keep the picture of the major facts in front of your mind's eye. It is also, however, essential that you become familiar with previous exam papers so that you will have some idea of how the questions are likely to be framed. Therefore, build up a good range of past exam papers (especially recent ones) and add these to your folder. When cows and sheep have grazed, they lie down and 'chew the cud': that is, they regurgitate what they have eaten and take time to digest the food thoroughly.

If you think over previous exam questions, this will help you not only recall what you have deposited in your memory, but also to develop your understanding of the issues. The questions from past exam papers, and further questions that you have developed yourself, will allow you to 'chew the cud'.

EXAMPLE Evaluate the pleasures and problems of keeping a pet.

Immediately you can see that you will r equire two lists and you can begin to work on documenting your r easons under each as below:

Problems

- Vet and food bills.
- Restrictions on holidays/weekends away .
- Friends may not visit.
- Allergies.
- Smells and cleanliness.
- Worries about leaving pet alone.

Pleasures

- Companionship.
- Fun and r elaxation.
- Satisfaction fr om caring.
- Cuddles.
- Contact with other pet owners.
- Good distraction fr om pr oblems.

You will have also noticed that the word 'evaluate' is in the question – so your mind must go to work on making judgements. You may decide to work through problems first and then through pleasures, or it may be your preference to compare point by point as you go along. Whatever conclusion you come to may be down to personal subjective preference but at least you will have worked through all the issues from both standpoints. The lesson is to ensure that part of your revision should include critical thinking as well as memory work.

You cannot think adequately without the raw materials provided by your memory deposits.

Employ effective mnemonics (memory aids)

The Greek word from which 'mnemonics' is derived refers to a tomb – a structure that is built in memory of a loved one, friend or respected person. 'Mnemonics' can be simply defined as aids to memory – devices that will help you recall information that might otherwise be difficult to retrieve from memory. For example, if you find an old toy in the attic of

your house, it may suddenly trigger a flood of childhood memories associated with it. Mnemonics can therefore be thought of as keys that open memory's storehouse.

Visualisation is one technique that can be used to aid memory. For example, the location method is where a familiar journey is visualised and you can 'place' the facts that you wish to remember at various landmarks along the journey – for example a bus stop, a car park, a shop, a store, a bend, a police station, a traffic light, and so on. This has the advantage of making an association of the information you have to learn with other material that is already firmly embedded and structured in your memory. Therefore, once the relevant memory is activated, a dynamic 'domino effect' will be triggered. However, there is no reason why you cannot use a whole toolkit of mnemonics. Some examples and illustrations of these are presented below.

1 *If you can arrange your subject matter in a logical sequence this will ensure that your series of facts will also connect with each other and one will trigger the other in recall.*
2 *You can use memory devices either at the stage of initial learning or when you later return to consolidate.*

Location method

Defined above

Visualisation

Turn information into pictures – for example, the example given about the problems and pleasures of pets could be envisaged as two tug-of-war teams that pull against each other. You could visualise each player as an argument and have the label written on his or her T-shirt. The war could start with two players and then be joined by another two and so on. In addition you could compare each player's weight to the strength of each argument. You might also want to make use of colour – your favourite colour for the winning team and the colour you dislike most for the losers!

Alliteration's artful aid

Find a series of words that all begin with the same letter. See the example below related to the experiments of Ebbinghaus.

Peg system

'Hang' information on to a term so that when you hear the term you will remember the ideas connected with it (an umbrella term). In the example on ageing there were four different types – biological, chronological, sociological and psychological. Under biological you could remember, menopause, hair loss, wrinkling, vision loss, hearing deterioration, and so on.

Hierarchical system

This is a development of the previous point with higher order, middle order and lower order terms. For example you could think of the continents of the world (higher order), and then group these into the countries under them (middle order). Under countries you could have cities, rivers and mountains (lower order).

Acronyms

Take the first letter of all the key words and make a word from these. An example from business is SWOT – Strengths, Weaknesses, Opportunities and Threats.

Mind maps

These have become very popular – they allow you to draw lines that stretch out from the central idea and to develop the subsidiary ideas in the same way. It is a little like the pegging and hierarchical methods combined and turned sideways! The method has the advantage of giving you the complete picture at a glance, although they can become a complex work of art!

Rhymes and Chimes

Words that rhyme and words that end with a similar sound (for example commemoration, celebration, anticipation). These provide another dimension to memory work by including sound. Memory can be enhanced when information is processed in various modalities – for example hearing, seeing, speaking, visualising.

A confidence booster

At the end of the nineteenth century, Ebbinghaus and his assistant memorised lists of nonsense words (could not be remembered by being attached to meaning), and then endeavoured to recall these. What they discovered was:

- Some wor ds could be r ecalled fr eely fr om memor y while others appear ed to be for gotten.
- Words that could not be r ecalled wer e later r ecognised as belonging to the lists (that is, they wer e not new additions).
- When the lists wer e jumbled into a dif ferent sequence, the experimenters were able to r e-jumble them into the original sequence.
- When the wor ds that wer e 'for gotten' wer e lear ned again, the lear ning process was much easier the second time (that is, ther e was evidence of r e-learning savings).

The four points of this experiment can be remembered by alliteration: Recall, Recognition, Reconstruction and Re-learning savings. This experiment has been described as a confidence booster because it demonstrates that memory is more powerful than is often imagined, especially when we consider that Ebbinghaus and his assistant did not have the advantage of processing the meaning of the words.

Alternate between methods

It is not sufficient to present outline points in response to an exam question (although it is better to do this than nothing if you have run out of time in your exam). Your aim should be to put 'meat on the bones' by adding substance, evidence and arguments to your basic points. You should work at finding the balance between the two methods – outline

revision cards might be best reserved for short bus journeys, whereas extended reading might be better employed for longer revision slots at home or in the library. Your ultimate goal should be to bring together an effective, working approach that will enable you to face your exam questions comprehensively and confidently.

In revision it is useful to alternate between scanning over your outline points, and reading through your notes, articles, chapters, and so on in an in-depth manner. Also, the use of different times, places and methods will provide you with the variety that might prevent monotony and facilitate freshness.

EXAMPLE Imagine that you are doing a course on the human body.

Your major outline topics might be:

- Names, positions and purpose of bones in the body .
- Names and position of or gans in the body .
- The or gans and chemicals associated with digestion.
- Composition, function and r outes of blood.
- Parts and pr ocesses of the body associated with br eathing.
- Components and dynamics of the ner vous and lymphatic systems.
- Structure, natur e and purpose of the skin.
- Role of the brain in contr olling and mediating the above systems.

This outline would be your overall, bird's eye view of the course. You could then choose one of the topics and have all your key terms under that. For example, under digestion you might have listed: mouth, oesophagus, stomach, duodenum, intestine, liver, vagus nerve, hypothalamus, hydrochloric acid and carbohydrates. In order to move from memory to understanding you would need to consider the journey of food through the human digestive system.

If you alternate between memory work and reading, you will soon be able to think through the processes by just looking at your outlines.

Revising with others

If you can find a few other students to revise with, this will provide another fresh approach to the last stages of your learning. First ensure that others carry their workload and are not merely using the hard work of others as a short cut to success. Of course you should think of group sessions as one of the strings on your violin, but not the only string. This collective approach would allow you to assess your strengths and weaknesses (showing you where you are off track), and to benefit from the resources and insights of others. Before you meet up you can each design some questions for the whole group to address. The group could also go through past exam papers and discuss the points that might provide an effective response to each question. It should not be the aim of the group to provide standard and identical answers for each group member to mimic. Group work is currently deemed to be advantageous by educationalists, and team work is held to be a desirable employability quality.

Each individual should aim to use their own style and content whilst drawing on and benefiting from the group's resources.

EXERCISE

Make a list of the advantages and disadvantages of revising in small groups.

Advantages	Disadvantages
1	.....
2	.....
3	.....
4	.....
5	.....

Can the disadvantages be eliminated or at least minimised?

Checklist – good study habits for revision time:

- ✓ Set a date for the 'of ficial' beginning of r evision and pr epare for 'r evision mode'.
- ✓ Do not for ce cramming by leaving r evision too late.
- ✓ Take br eaks fr om r evision to avoid saturation.
- ✓ Indulge in r elaxing activities to give your mind a br eak fr om pr essur e.
- ✓ Minimise or eliminate use of alcohol during the r evision season.
- ✓ Get into a good r hythm of sleep to allow r enewal of your mind.
- ✓ Avoid excessive caf feine especially at night so that sleep is not disr upted.
- ✓ Try to adher e to r egular eating patter ns.
- ✓ Try to have a brisk walk in fr esh air each day (for example, in the park).
- ✓ Avoid excessive dependence on junk food and snacks.

EXERCISE

Write your own checklist on what you add to the revision process to ensure it was not just a memory exercise.

- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....

In the above exercise, what you could add to memory work during revision might include using past exam papers, setting problem-solving tasks, doing drawings to show connections and directions between various concepts, explaining concepts to student friends in joint revision sessions, devising your own mock exam questions.

3.5 exam hints and tips

This section will show you how to:

- Develop strategies for contr olling your ner vous ener gy.
- Tackle worked examples of time and task management in exams.
- Attend to the practical details associated with the exam.
- Stay focused on the exam questions.
- Link r evision outlines to strategy for addr essing exam questions.

Handling your nerves

Exam nerves are not unusual and it has been concluded that test anxiety arises because of the perception that your performance is being evaluated, that the consequences are likely to be serious and that you are working under the pressure of a time restriction. However, it has also been asserted that the activation of the autonomic nervous system is adaptive in that it is designed to prompt us to take action in order to avoid danger. If you focus on the task at hand rather than on feeding a downward negative spiral in your thinking patterns, this will help you keep your nerves under control. In the run up to your exams you can practise some simple relaxation techniques that will help you bring stress under control.

It is a very good thing if you can interpret your nervous reactions positively, but the symptoms are more likely to be problematic if you interpret them negatively, pay too much attention to them or allow them to interfere with your exam preparation or performance.

Practices that may help reduce or buffer the effects of exam stress

- Listening to music.
- Going for a brisk walk.

- Simple br eathing exer cises.
- Some muscle r elaxation.
- Watching a movie.
- Enjoying some laughter .
- Doing some exer cise.
- Relaxing in a bath (with music if pr eferred).

The best choice is going to be the one (or combination) that works best for you – perhaps to be discovered by trial and error. Some of the above techniques can be practised on the morning of the exam, and even the memory of them can be used just before the exam. For example, you could run over a relaxing tune in your head, and have this echo inside you as you enter the exam room. The idea behind all this is, first, stress levels must come down, and second, relaxing thoughts will serve to displace stressful reactions. It has been said that stress is the body's call to take action, but anxiety is a maladaptive response to that call.

It is important you are convinced that your stress levels can come under control, and that you can have a say in this. Do not give anxiety a vacuum to work in.

Time management with examples

The all-important matter as you approach an exam is to develop the belief that you can take control over the situation. As you work through the list of issues that you need to address, you will be able to tick them off one by one. One of the issues you will need to be clear about before the exam is the length of time you should allocate to each question. Sometimes this can be quite simple (although it is always necessary to read the rubric carefully) – for example, if two questions are to be answered in a two-hour paper, you should allow one hour for each question. If it is a two-hour paper with one essay question and five shorter answers, you could allow one hour for the essay and 12 minutes each for the shorter questions. However, you always need to check out the weighting for the marks on each question, and you will also need to deduct whatever time it takes you to read over the paper and to choose your questions. See if you can work out a time management strategy in each of the following scenarios. More importantly, give yourself some practice on the papers you are likely to face.

Remember to check if the structure of your exam paper is the same as in previous years, and do not forget that excessive time on your 'strongest' question may not compensate for very poor answers to other questions Also ensure that you read the rubric carefully in the exam.

EXERCISE

Examples for working out the division of exam labour by time:

1 **A three-hour paper with four compulsory questions (equally weighted in marks).**

2 **A three-hour paper with two essays and ten short questions (each of the three sections carries one third of the marks).**

3 **A two-hour paper with two essay questions and 100 multiple-choice questions (half the marks is on the two essays and the other half of the marks is on the multiple choice section).**

Get into the calculating frame of mind and be sure to have the calculations done before the exam. Ensure that the structure of the exam has not changed since the last one. Also deduct the time taken to read over the paper in allocating time to each question.

Suggested answers to a previous exercise

1 This allows 45 minutes for each question (4 questions × 45 minutes = 2 hours). However , if you allow 40 minutes for each question this will give you 20 minutes (4 questions × 5 minutes) to r ead over the paper and plan your outlines.

2 In this example you can spend o ne hour on each of the two major questions, and o ne hour on the t en shor t questions. For the two major questions you could allow t en minutes for r eading and planning

on each, and 50 minutes for writing. In the short questions, you could allow six minutes in total for each (10 questions × 6 minutes = 60 minutes). However, if you allow approximately one minute of reading and planning time, this will allow five minutes of writing time for each question.

3 In this case you have to divide 120 minutes by three questions – this allows 40 minutes for each. You could for example allow five minutes reading/planning time for each essay and 35 minutes for writing (or ten minutes reading/planning and 30 minutes writing). After you have completed the two major questions you are left with 40 minutes to tackle the 100 multiple-choice questions.

You may not be able to achieve total precision in planning time for tasks, but you will have a greater feeling of control and confidence if you have some reference points to guide you.

Task management with examples

After you have decided on the questions you wish to address, you then need to plan your answers. Some students prefer to plan all outlines and draft work at the beginning, whilst other prefer to plan and address one answer before proceeding to address the next question. Decide on your strategy before you enter the exam room and stick to your plan. When you have done your draft outline as rough work, you should allocate an appropriate time for each section. This will prevent you from excessive treatment of some aspects whilst falling short on other parts. Such careful planning will help you achieve balance, fluency and symmetry.

Keep awareness of time limitations and this will help you to write succinctly, keep focused on the task and this will prevent you dressing up your responses with unnecessary padding.

Some students put as much effort into their rough work as they do into their exam essay.

An over-elaborate mind map may give the impression that the essay is little more than a repetition of this detailed structure, and that the quality of the content has suffered because too much time was spent on the plan.

EXERCISE

Try the following exercise.

Work within the time allocated for the following outline allowing for one hour on the question. Deduct ten minutes taken at the beginning for choice and planning.

Discuss whether it is justifiable to ban cigarette smoking in pubs and restaurants.

1 Arguments for a ban

(a) Health risks by sustained exposure to passive smoking.

(b) Employees (such as students) suffer unfairly.

(c) Children with parents may also be victims.

2 Arguments against a ban

(a) Risks may be exaggerated.

(b) Dangerous chemicals and pollutants in environment ignored by governments.

(c) Non-smokers can choose whether to frequent smoking venues.

3 Qualifying suggestions

(a) Better use of ventilation and extractor fans.

(b) Designated non-smoking areas.

(c) Pubs and restaurants should be addressed separately in relation to a ban.

Attend to practical details

This short section is designed to remind you of the practical details that should be attended to in preparation for an exam. There are always students who turn up late, or to the wrong venue, or for the wrong exam, or do not turn up at all! Check and re-check that you have all the details

of each exam correctly noted. What you don't need is to arrive late and then have to tame your panic reactions. The exam season is the time when you should aim to be at your best.

Turn up to the right venue in good time so that you can quieten your mind and bring your stress under control.

Make note of the following details and check that you have taken control of each one.

Checklist – practical exam details:

- ✓ Check that you have the cor rect venue.
- ✓ Make sur e you know how to locate the venue befor e the exam day .
- ✓ Ensur e that the exam time you have noted is accurate.
- ✓ Allow suf ficient time for your jour ney and consider the possibility of delays.
- ✓ Bring an adequate supply of stationer y and include back up.
- ✓ Bring a watch for your time and task management.
- ✓ You may need some liquid such as a small bottle of still water .
- ✓ You may also need to bring some tissues.
- ✓ Obser ve whatever exam r egulations your university/college has set in place.
- ✓ Fill in r equired personal details befor e the exam begins.

Control wandering thoughts

In a simple study conducted in the 1960s, Ganzer found that students who frequently lifted their heads and looked away from their scripts during exams tended to perform poorly. This makes sense because it implies that the students were taking too much time out when they should have been on task. One way to fail your exam is to get up and walk out of the test room, but another way is to 'leave' the test room mentally by being preoccupied with distracting thoughts. The distracting thoughts may be either related to the exam itself or totally irrelevant to it. The net effect of both these forms of intrusion is to distract you from the task at hand and debilitate your test performance. Read over the two lists of distracting thoughts presented below.

Typical test relevant thoughts (evaluative)

- I wish I had pr epared better.
- What will the examiner think?
- Others ar e doing better than me.
- What I am writing is nonsense.
- Can't r emember impor tant details.

Characteristic test irrelevant thoughts (non-evaluative)

- Looking for ward to this weekend.
- Which video should I watch tonight?
- His r emark r eally annoyed me yester day.
- Wonder how the game will go on Satur day?
- I wonder if he/she r eally likes me?

Research has consistently shown that distracting, intrusive thoughts during an exam are more detrimental to performance than stressful symptoms such as sweaty palms, dry mouth, tension, trembling, and so on. Moreover, it does not matter whether the distracting thoughts are negative evaluations related to the exam or are totally irrelevant to the exam. The latter may be a form of escape from the stressful situation.

Practical suggestions for controlling wandering thoughts

- Be awar e that this pr oblem is detrimental to per formance.
- Do not look ar ound to find distractions.
- If distracted, write down 'keep focused on task'.
- If distracted again, look back at the above and continue to do this.
- Star t to draft r ough work as soon as you can.
- If you str uggle with initial focus then r e-read or elaborate on your r ough work.
- If you have commenced your essay r e-read you last paragraph (or two).
- Do not thr ow fuel on your distracting thoughts – star ve them by r e-engaging with the task at hand.

Links to revision

If you have followed the guidelines given for revision, you will be well equipped with outline plans when you enter the exam room. You may have chosen to use headings and subheadings, mind maps, hierarchical

approaches or just a series of simple mnemonics. Whatever method you choose to use, you should be furnished with a series of memory triggers that will open the treasure-house door for you once you begin to write.

Although you may have clear templates with a definite structure or framework for organising your material, you will need to be flexible about how this should be applied to your exam questions.

For example, imagine that films are one of the topics that you will be examined on. You decide to memorise lists of films that you are familiar with under categorical headings in the following manner.

Romantic Comedy	*War/History/Fantasy*	*Space/Invasion*
Notting Hill	*Braveheart*	*Star Wars*
Pretty Woman	*Gladiator*	*Independence Day*
Along Came Polly	*First Knight*	*Alien*
Four Weddings and a Funeral	*Troy*	*Men in Black*
Adventure/Fantasy	*Horror/Supernatural*	
Harry Potter	*Poltergeist*	
Lord of the Rings	*The Omen*	
Alice in Wonderland	*Sixth Sense*	
Labyrinth	*What Lies Beneath*	

The basic mental template might be these and a few other categories. You know that you will not need every last detail, although you may need to select a few from each category. For example, you might be asked to:

(a) Compare and contrast features of comedy and horror.
(b) Comment on films that have realistic moral lessons in them.
(c) Discuss films that might be construed as a propaganda exercise.
(d) Identify films where the characters are more important than the plot and vice versa.

Some questions will put a restriction on the range of categories you can use (a), while others will allow you to dip into any category (b, c and d). A question about fantasy would allow you scope across various categories.

Restrict your material to what is relevant to the question, but bear in mind that this may allow you some scope.

The art of 'name dropping'

In most topics at university you will be required to cite studies as evidence for your arguments and to link these to the names of researchers, scholars or theorists. It will help if you can use the correct dates or at least the decades, and it is good to demonstrate that you have used contemporary sources, and have done some independent work. A marker will have dozens if not hundreds of scripts to work through and they will know if you are just repeating the same phrases from the same sources as every one else. There is inevitably a certain amount of this that must go on, but there is room for you to add fresh and original touches that demonstrate independence and imagination.

Give the clear impression that you have done more than the bare minimum and that you have enthusiasm for the subject. Also, spread the use of researchers names across your exam essay rather than compressing them into, for example, the first and last paragraphs.

Flight, fight or freeze

As previously noted, the autonomic nervous system (ANS) is activated when danger or apparent danger is imminent. Of course the threat does not have to be physical, as in the case of an exam, a job interview, a driving test or a TV appearance. Indeed the ANS can be activated even at the anticipation of a future threat. However, the reaction is more likely to be stronger as you enter into the crucial time of testing or challenge. Symptoms may include deep breathing, trembling, headaches, nausea, tension, dry mouth and palpitations. How should we react to these once they have been triggered? A postman might decide to run away from a barking dog and run the risk of being chased and bitten. A second possible response is to freeze in the spot – this might arrest the animal in its tracks, but is no use in an exam situation. In contrast, to fight might not be the best strategy against the dog, but will be more productive in an exam: that is, you are going into the exam room to 'tackle' the questions, and not to run away from the challenge before you.

The final illustration below uses the analogy of archery to demonstrate how you might take control in an exam.

EXAMPLE Lessons from archery

- Enter the exam r oom with a quiver full of ar rows – all the points you will need to use.
- Eye up the tar get boar d you ar e to shoot at – choose the exam questions.
- Stand in a good position for balance and vision – pr epare your time management.
- Prepare your bow and ar row and take aim at the tar get – keep focused on the task at hand and do not be sidetracked.
- Pull the string of the bow back to get maximum thr ust on the ar row – match your points to the appr opriate question.
- Aim to hit the boar d wher e the best marks ar e (bull's eye or close) – do not be content with the minimum standar d such as a mer e pass.
- Pull out ar rows and shoot one after another to gain maximum hits and advantage – do not be content with pr eparing one or two str ong points.
- Make sur e your ar rows ar e sharp and the suppor ting bow and string ar e fir m – choose r elevant points and suppor t with evidence.
- Avoid wasted ef fort by loose and car eless shots – do not dr ess up your essay with unnecessar y padding.

EXERCISE

Write your own checklist on the range of combined skills and personal qualities that you will need to be at your best in an exam.

✓ .....

✓ .....

✓ .....

✓ .....

✓ .....

With reference to the above exercise – skills might include such things as critical thinking, time and task management, focus on issues, and quick identification of problems to address. Personal qualities might include factors such as confidence, endurance, resilience, and stress control.

3.6

tips on interpreting essay and exam questions

This section will show you how to:

- Focus on the issues that ar e relevant and central.
- Read questions car efully and take account of all the wor ds.
- Produce a balanced critique in your outline str uctures.
- Screen for the key wor ds that will shape your r esponse.
- Focus on dif ferent shades of meaning between 'critique', 'evaluate', 'discuss' and 'compar e and contrast'.

What do you see?

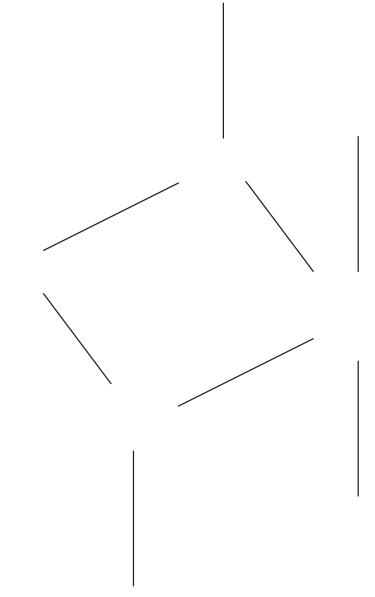


Figure 3.2 Visual illusion

The suggested explanation for visual illusions is the inappropriate use of cues – that is, we try to interpret three-dimensional figures in the real world with the limitations of a two-dimensional screen (the retina in the eye). We use cues such as shade, texture, size, background and so on to interpret distance, motion, shape, and the like and we sometimes use these inappropriately. Another visual practice we engage in is to 'fill in the blanks' or join up the lines (as in the case of the nine lines above – which we might assume to be a chair). Our tendency is to impose the nearest similar and familiar template on that which we think we see. The same occurs in the social world – when we are introduced to someone of a different race we may (wrongly) assume certain things about them. The same can also apply to the way you read exam or essay questions. In these cases you are required to 'fill in the blanks' but what you fill in may be the wrong interpretation of the question. This is especially likely if you have primed yourself to expect certain questions to appear in an exam, but it can also happen in coursework essays. Although examiners do not deliberately design questions to trick you or trip you up, they cannot always prevent you from seeing things that were not designed to be there. When one student was asked what the four seasons are, the response given was, 'salt, pepper, mustard and vinegar'. This was not quite what the examiner had in mind!

Go into the exam room, or address the coursework essay well prepared, but be flexible enough to structure your learned material around the slant of the question.

A politician's answer

Politicians are renowned for refusing to answer questions directly or for evading them through raising other questions. A humorous example is that when a politician was asked, 'Is it true that you always answer questions by asking another?', the reply given was, 'Who told you that?' Therefore, make sure that you answer the set question, although there may be other questions that arise out of this for further study that you might want to highlight in your conclusion. As a first principle you must answer the set question and not another question that you had hoped for in the exam or essay.

Do not leave the examiner feeling like the person who interviews a politician and goes away with the impression that the important issues have been sidestepped.

EXAMPLE Discuss the strategies for improving the sale of fresh fruit and vegetables in the marketplace at the point of delivery to the customer.

Directly relevant points

- Stall and fruit kept clean.
- Well presented/arranged produce.
- Use of colour and variety.
- Position of stall in market (for example, smells).
- Use of free samples.
- Appearance and manner of assistants.
- Competitive prices.

Less relevant points

- Advantages of organic growth.
- Arguments for vegetarianism.
- Cheaper transport for produce.
- Value of locally grown produce.
- Strategies for pest control in growth.
- Arguments for refrigeration in transit.
- Cheaper rents for markets.

Although some of the points listed in the second column may be relevant to sales overall, they are not as directly relevant to sales 'in the marketplace at the point of delivery to the customer'. If the question had included the quality of the produce then some of those issues should be addressed. Also it could be argued that some of these issues could be highlighted on a board at the stall – for example 'Only organically grown produce is sold at this stall'. So some of the points could be mentioned briefly in this way without going off at a tangent.

Be ready to resist the wealth of fascinating material at your disposal that is not directly relevant to your question.

Missing your question

A student bitterly complained after an exam that the topic he had revised so thoroughly had not been tested in the exam. The first response to that is that students should always cover enough topics to avoid selling themselves short in the exam – the habit of 'question spotting' is always a risky game to play. However, the reality in the anecdotal example was that the question the student was looking for was there, but he had not seen it. He had expected the question to be couched in certain words and he could not find these when he scanned over the questions in blind panic. Therefore, the simple lesson is always read over the questions carefully, slowly and thoughtfully. This practice is time well spent.

You can miss the question if you restrict yourself to looking for a set form of words and if you do not read over all the words carefully.

Write it down

If you write down the question you have chosen to address, and perhaps quietly articulate it with your lips, you are more likely to process fully its true meaning and intent. Think of how easy it is to misunderstand a question that had been put to you verbally because you have misinterpreted the tone or emphasis.

If you read over the question several times you should be aware of all the key words and will begin to sense the connections between the ideas, and will envisage the possible directions you should take in your response.

Take the following humorous example:

(a) What is that on the road ahead?
(b) What is that on the road, a head?

Question (a) calls for the identification of an object (what is that?), but question (b) has converted this into an object that suggests there has been a decapitation! Ensure therefore that you understand the direction the question is pointing you towards so that you do not go off at a tangent. One word in the question that is not properly attended to can throw you completely off track as in the following example:

(a) Discuss whether the love of money is the root of all evil.
(b) Discuss whether money is the root of all evil.

These are two completely different questions as (a) suggests that the real problem with money is inherent in faulty human use – that is, money itself may not be a bad thing if it is used as a servant and not a master. Whereas (b) may suggest that behind every evil act that has ever been committed money is likely to have been implicated somewhere in the motive.

Pursue a critical approach

In degree courses you are usually expected to write critically rather than merely descriptively, although it may be necessary to use some minimal descriptive substance as the raw material for your debate.

EXAMPLE Evaluate the evidence whether the American astronauts really walked on the moon, or whether this was a stage-managed hoax in a studio.

Arguments for studio

- Flag blowing on moon?
- Explain the shadows.
- Why no stars seen?
- Why little dust blowing at landing?
- Can humans sur vive passing thr ough the radiation belt?

Arguments for walking

- Communicate with laser r eflectors left on moon.
- Retrieved r ocks show patter ns that ar e not ear thly.
- How could such a hoax be pr otected?

- American activities wer e monitor ed by Soviets.
- Plausible explanations for ar guments against walking.

Given that the question is about a critical evaluation of the evidence, you would need to address the issues one by one from both standpoints. What you should not do is digress into a tangent about the physical characteristics of the Beagle space ship or the astronauts' suits. Neither should you be drawn into a lengthy description of lunar features and contours even if you have in-depth knowledge of these.

Analyse the parts

In an effective sports team the end product is always greater than the sum of the parts. Similarly, a good essay cannot be constructed without reference to the parts. Furthermore, the parts will arise as you break down the question into the components it suggests to you. Although the breaking down of a question into components is not sufficient for an excellent essay, it is a necessary starting point.

To achieve a good response to an exam or essay question, aim to integrate all the individual issues presented in a manner that gives shape and direction to your efforts.

EXAMPLE 1 Discuss whether the preservation and restoration of listed buildings are justified.

Two parts to this question are clearly suggested – preservation and restoration, and you would need to do justice to each in your answer. Other issues that arise in relation to these are left for you to suggest and discuss. Examples might be finance, prioritisation, poverty, beauty, culture, modernisation, heritage and tourism.

EXAMPLE 2 Evaluate the advantages and disadvantages of giving students course credit for participation in experiments.

This is a straightforward question in that you have two major sections – advantages and disadvantages. You are left with the choice of the issues that you wish to address, and you can arrange these in the order you

prefer. Your aim should be to ensure that you do not have a lopsided view of this even if you feel quite strongly one way or the other.

EXAMPLE 3 Trace in a critical manner Western society's changing attitudes to the corporal punishment of children.

In this case you might want to consider the role of governments, the Church, schools, parents and the media. However, you will need to have some reference points to the past as you are asked to address the issue of change. There would also be scope to look at where the strongest influences for change arise and where the strongest resistance comes from. You might argue that the changes have been dramatic or evolutionary.

Give yourself plenty of practice at thinking of questions in this kind of way – both with topics on and not on your course. Topics not on your course that really interest you may be a helpful way to 'break you in' to this critical way of thinking.

Luchins and learning sets

In a series of experiments, Luchins allowed children to learn how to solve a problem that involved pouring water from and into a series of jugs of various sizes and shapes. He then gave them other problems that could be solved by following the same sequence. However, when he later gave them another problem that could be solved through a simpler sequence, they went about solving it through the previously learned procedure. In this case the original approach was more difficult but it had become so set in the children's minds that they were blinded to the shorter, more direct route.

EXAMPLE How much did the wealthy Scottish man leave behind?

The story is told of a wealthy Scottish man who died, and no one in his village knew how much he had left behind. The issue was debated and gossiped about for some time, but one man claimed that he knew how much the man had left. He teased all the debaters and gossips in the village night after night. Eventually he let his big secret out, and the answer was that the rich man had left 'all of it' behind! No one in the village had been able to

work out the mischievous man's little ruse because of the convergent thinking style they used. Some exam questions may require you to be divergent in the way you think (that is, not just one obvious solution to the problem). This may mean being like a detective in the way you investigate and problem solve. The only difference is that you may need to set up the problem as well as the solution!

Get into the habit of 'stepping sideways' and looking at questions from several angles. The best way to do this is by practice, for example on previous exam papers.

Checklist – ensuring that questions are understood before being fully addressed:

- ✓ Read over the chosen question several times.
- ✓ Write it down to ensur e that it is clear .
- ✓ Check that you have not omitted any impor tant aspect or point of emphasis.
- ✓ Ensure that you do not wr ongly impose pr econceived expectations on the question.
- ✓ Break the question into par ts (dismantle and r ebuild).

EXERCISE

Write your own checklist on any additional points of guidance for exams that you have picked up from tutors or textbooks.

- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....
- ✓ .....

When asked to discuss

Students often ask how much of their own opinion they should include in an essay. In a discussion, when you raise one issue, another one can arise out of it. One tutor used to introduce his lectures by saying that he was going to 'unpack' the arguments. When you unpack an object (such as a new desk that has to be assembled), you first remove the overall packaging, such as a large box, and then proceed to remove the covers from all the component parts. After that you attempt to assemble all the parts, according to the given design, so that they hold together in the intended manner. In a discussion your aim should be not just to identify and define all the parts that contribute, but also to show where they fit (or don't fit) into the overall picture.

Although the word 'discuss' implies some allowance for your opinion, remember that this should be informed opinion rather than groundless speculation. Also, there must be direction, order, structure and end project.

Checklist – features of a response to a 'discuss' question:

- ✓ Contains a chain of issues that lead into each other in sequence.
- ✓ Clear shape and dir ection ar e unfolded in the pr ogression of the ar gument.
- ✓ Underpinned by r eference to findings and cer tainties.
- ✓ Identification of issues wher e doubt r emains.
- ✓ Tone of ar gument may be tentative but should not be vague.

If a critique is requested

One example that might help clarify what is involved in a critique is the hotly debated topic of the physical punishment of children. It would be important in the interests of balance and fairness to present all sides and shades of the argument. You would then look at whether there is available evidence to support each argument, and you might introduce issues that have been coloured by prejudice, tradition, religion and legislation. It would be an aim to identify emotional arguments and arguments based on intuition, and to get down to those arguments that really have

solid evidence-based support. Finally you would want to flag up where the strongest evidence appears to lie, and you should also identify issues that appear to be inconclusive. It would be expected that you should, if possible, arrive at some certainties.

EXERCISE

Write your own summary checklist for the features of a critique. You can either summarise the above points, or use your own points or a mixture of the two.

✓ .....

✓ .....

✓ .....

✓ .....

✓ .....

If asked to compare and contrast

When asked to compare and contrast, you should be thinking in terms of similarities and differences. You should ask what the two issues share in common, and what features of each are distinct. Your preferred strategy for tackling this might be to work first through all the similarities and then through all the contrasts (or vice versa). On the other hand, you could work through a similarity and contrast, followed by another similarity and contrast and so on.

EXAMPLE Compare and contrast the uses of tea and coffee as beverages.

Similarities

- Usually dr unk hot.
- Can be dr unk without food.
- Can be taken with a snack or meal.
- Can be dr unk with milk.
- Can be taken with honey , sugar or sweeteners.
- Both contain caf feine.
- Both can be addictive.

Contrasts

- Differences in taste.
- Tea perhaps preferred at night.
- Differences in caffeine content.
- Coffee more bitter.
- Coffee sometimes taken with cream or whiskey.
- Each perhaps preferred with different foods.
- Coffee preferred for hangover.

When you compare and contrast your should aim to paint a true picture of the full 'landscape'.

Whenever evaluation is requested

A worked example of evaluation – TV soap opera director:

Imagine that you are a TV director for a popular soap opera. You have observed in recent months that you have lost some viewers to an alternative soap opera on a rival channel. All is not yet lost because you still have a loyal core of viewers who have remained faithful. Your programme has been broadcasted for ten years and there has, until recently, been little change in viewing figures. The rival programme has used some fresh ideas and new actors and has a big novelty appeal. It will take time to see if their level of viewing can be sustained, but you run the risk that you might lose some more viewers at least in the short term. Conversely, with some imagination you might be able to attract some viewers back. However, there have been some recent murmurings about aspects of the programme being stale, repetitive and predictable. You have been given the task of evaluating the programme to see if you can ascertain why you have retained the faithful but lost other viewers, and what you could do to improve the programme without compromising the aspects that work. In your task you might want to review past features (retrospective), outline present features (perspective) and envisage positive future changes (prospective).

This illustration may provoke you to think about how you might approach a question that asks you to evaluate some theory or concept in your own academic field of study. Some summary points to guide you are presented below:

- Has the theory/concept stood the test of time?
- Is there a supportive evidence base that would not easily be overturned?
- Are there questionable elements that have been or should be challenged?
- Does more recent evidence point to a need for modification?
- Is the theory/concept robust and likely to be around for the foreseeable future?
- Could it be strengthened through being merged with other theories/concepts

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EXERCISE

Write your own checklist on what you remember or understand about each of the following: 'Discuss', 'Compare and Contrast', 'Evaluate' and 'Critique' (just a key word or two for each). If you find this difficult then you should read the section again and then try the exercise.

✓ .....

✓ .....

✓ .....

✓ .....

It should be noted that the words presented in the above examples might not always be the exact words that will appear on your exam script – for example you might find 'analyse', or 'outline' or 'investigate' and so on. The best advice is to check over your past exam papers and familiarise yourself with the words that are most recurrent.

In summary, this chapter has been designed to give you reference points to measure where you are at in your studies, and to help you map out the way ahead in manageable increments. It should now be clear that learning should not merely be a mechanical exercise, such as just memorising and reproducing study material. Quality learning also involves making connections between ideas, thinking at a deeper level by attempting to understand your material and developing a critical approach to learning. However, this cannot be achieved without the discipline of preparation for lectures, seminars and exams, or without learning to structure your material (headings and subheadings) and to set each unit of learning within its overall context in your subject and programme. An important device in learning is to develop the ability to ask questions (whether written, spoken or silent). Another useful device

in learning is to illustrate your material and use examples that will help make your study fun, memorable and vivid. It is useful to set problems for yourself that will allow you to think through solutions and therefore enhance the quality of your learning.

On the one hand there are the necessary disciplined procedures such as preparation before each learning activity and consolidation afterwards. It is also vital to keep your subject materials in organised folders so that you can add/extract/replace materials when you need to. On the other hand there is the need to develop personality qualities such as feeding your confidence, fuelling your motivation and turning stress responses to your advantage. This chapter has presented strategies to guide you through finding the balance between these organised and dynamic aspects of academic life.

Your aim should be to become an 'all round student' who engages in and benefits from all the learning activities available to you (lectures, seminars, tutorials, computing, labs, discussions, library work and so on), and to develop all the academic and personal skills that will put you in the driving seat to academic achievement. It will be motivating and confidence building for you, if you can recognise the value of these qualities, both across your academic programme and beyond graduation to the world of work. They will also serve you well in your continued commitment to life-long learning.

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glossary

Acceptance sampling	Taking a random sample from a lot of material to be inspected.
Appraisal costs	Costs associated with controlling quality through the use of measuring and testing products and processes to ensure conformance to quality specifications.
Batch process	A process type where products are grouped into batches where size can range from one to over 100.
Benchmarking	The continuous measurement of an organisation's products and processes against a company recognised as a leader in that industry.
Business process simulation	The use of computer software, in the context of a process-based change, that allows the operations of a business to be simulated.
Cell layout	A layout type where cells are created from placing together resources which serve a subset of the total range of products or services.
Chase demand	A capacity planning strategy that seeks to match output to the demand pattern over time.
Computer-integrated manufacture (CIM)	The automation of the product and process design, planning and control and manufacture of the product.
Concurrent design	When contributors to the stages of the design effort provide their expertise together throughout the design process as a team.

Continuous improvement	A philosophy which believes that it is possible to get to the ideals of JIT by a continuous stream of ideas over time.
Continuous process	An operation that produces a very high volume of a standard product, usually by a continuous flow.
Cost	The finance required to obtain the inputs and manage the transformation process which produces finished goods and services.
Cumulative representation	A running total of inventory, which should always meet or exceed cumulative demand.
Demand management	A capacity planning strategy that attempts to adjust demand to meet available capacity.
Dependability	Consistently meeting a promised delivery time for a product or service to a customer.
Economies of scale	Savings that result if a facility is expanded and fixed costs remain the same, so that the average cost of producing each unit will fall.
Economies of scope	Savings that result from the ability to produce many products in one highly flexible production facility more cheaply than in separate facilities.
Enterprise Resource Planning (ERP)	An IT system that provides a single solution from a single supplier with integrated functions for the major business areas.
Ergonomics	A collection of information about human characteristics and behaviour to understand the effect of design methods and environment.
Failure Mode and Effect Analysis (FMEA)	A systematic approach to identifying the cause and effect of product failures.
Fixed position layout	Used when the product or service cannot be moved and the transforming process must take place at the location of product creation or service delivery.

Flexibility	The ability of an organisation to change what it does quickly. In terms of products or services this can relate to introducing new designs, changing the mix, changing the overall volume and changing the delivery timing.
Focus	The alignment of particular market demands with individual facilities to reduce the level of complexity generated when attempting to service a number of different market segments from an individual organisation.
Group technology	The process of grouping products for manufacture or services for delivery.
Job characteristics model	Links job characteristics with the desired psychological state of the individual and the outcomes in terms of motivation and job performance.
Jobbing process	The process of making a low volume product to a customer specification.
JIT and Lean Operations	Integration of a philosophy and techniques designed to improve performance.
Lag capacity	When capacity is added only when extra demand is present that would use the additional resources.
Lead capacity	To maintain extra capacity above forecast demand and so maintain a capacity 'cushion'.
Learning curves	Provide an organisation with the ability to predict the improvement in productivity that can occur as experience is gained of a process.
Level capacity	A capacity planning strategy that sets processing capacity at a uniform level throughout the planning period regardless of fluctuations in forecast demand.
Line balancing	Aims to ensure that the output of each production stage in a line/mass layout is equal and maximum efficiency is achieved.

Loading	Involves determining the available capacity for each stage in a process and allocating a work task to that stage.
Mass/Line process	A process that produces products of high volume and low variety.
Mass service	Service process type that operates with a low variety and high volume.
Match capacity	A capacity planning strategy that aims to obtain capacity to match forecast demand.
Materials Requirements Planning (MRP)	An information system used to calculate the requirements for component materials needed to produce items.
Optimised Production Technology (OPT)	An operations control system that is based on the identification of bottlenecks within the production process.
Process layout	A layout in which resources that have similar processes or functions are grouped together.
Product layout	A layout in which the resources required for a product or service are arranged around the needs of that product or service.
Production flow analysis	A group technology technique that can be used to identify families of parts.
Professional service	Service process type characterised by high levels of customisation and customer contact.
Project process	A process that is used to make a one-off product to a customer specification. A feature of a project process is that the location of the product is stationary.
Quality	How well the product or service meets customer needs.
Quality Functional Deployment (QFD)	Translates the voice of the customer into technical design requirements.
Scheduling	The allocation of a start and finish time for an order.

Sequencing	The sequential assignment of tasks to individual processes.
Service blueprinting	A charting device for processes which documents the interaction between the customer and service provider.
Service package	The combination of goods and services that comprise a service.
Service shop	Service process type which operates with a medium amount of variety and volume.
Six Sigma	A company-wide initiative to reduce costs through process efficiency and increase revenues through process effectiveness.
Speed	The time delay between a customer request for a product or service and receipt of that product or service.
Statistical Process Control (SPC)	A sampling technique that checks the quality of an item which is engaged in a process.
Supply chain	The series of activities that move materials from suppliers, through operations to customers.
Total Preventative Maintenance (TPM)	A programme of routine maintenance that will help to reduce breakdowns.
Total Quality Management (TQM)	A philosophy that aims to make high quality, as defined by the customer, a primary concern throughout the organisation.
Value engineering (VE)	Eliminates unnecessary features and functions that do not contribute to the value or performance of the product.
Yield management	The use of demand management strategies aimed at maximising customer revenue in service organisations.

index