

Department of Business Management



Production & Operations Management

Only study guide for
MNO3701

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(Revised 2nd, 3rd and 4th editions 2002, 2005 and 2008)
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PREFACE

Welcome to Module MNO3701, which follows on from our second-year module, MNO2601. In MNO3701, we shall be examining production and operations management (POM) in more detail. We believe (and, hopefully, after your success in module MNO2601 you will agree with us) that production and operations is one of the more interesting and challenging specialist fields in business management. As we have argued in the past, the core of any business (or as we like to refer to it “the heart of any business”) is, in effect, what that business manufactures or produces (goods or products) and/or what it provides (services). Without these products and/or services to offer customers/clients, no business could think of even starting, let alone surviving or growing. Please note that the term “business” refers to a form of organisation in those countries that have western-style, free-market economies; a “business” in these countries either produces products or provides services.

We hope that while you were studying the second-year module, MNO2601, you saw the potential value of having some knowledge and practical experience of production and operations management, even if this knowledge and experience is limited to the rudimentary concepts, methods, tools and techniques of application. The purpose of such a basic understanding is, first of all, that you can manage this specialist discipline better and, secondly, that you can understand and appreciate the role and contribution of this function in interaction with the other business functions (eg marketing, financial, human resource management, etc). To reiterate what we said in MNO2601: if there is better management of the manufacturing/service processes that manufacture the products or provide the services, we believe these processes could be the key to creating, maintaining and improving the competitive advantage in terms of the production or operations-based performance objectives of higher quality, greater speed, dependability, flexibility and lower cost. Perhaps we should say here that by “better management” we mean running a business more efficiently and effectively (which, in fact, is the ultimate goal of production and operations management).

Now that you have thought, once again, about what the broad outlines of production and operations management entail, and why it is considered to be an important specialist discipline within the field of business management, we hope that you are glad that you have decided to continue your study of the concepts and methods involved in this specialist field. In this module, you will be required to master the skills of applying the tools and techniques and, we believe, appreciate the possible value of production and operations management and its potential contribution to successful businesses. We are certainly pleased about your decision to continue with your studies and we will do what we can to make your studies interesting, stimulating and rewarding – a productive experience, in fact! Enjoy your studies!

STEPS IN THE STUDY PROCESS

Do not merely study the textbook. This study guide is your “teacher” and it will “request” that you become actively involved in all activities in the study guide. It will refer you to sections in chapters without stating page numbers. As you start your study of Module MNO3701, production and operations management, we suggest that you follow the steps indicated below:

- Step 1: Try to obtain a “feeling” and interest for the subject or body of knowledge by getting an overview of the entire syllabus for MNO3701. You can do this by reading the contents page of this study guide (page iii). You will notice that the syllabus is divided into three main parts (parts I, II and III). Each part contains a number of topics (part I – topics 1 and 2; part II – topics 3, 4, 5, 6 and 7; part III – topics 8, 9 and 10).
- Step 2: Get an overview of the contents of each of the three parts of the syllabus. You can do this by reading the title page of each part (these pages also serve as “mind maps”) of this study guide (part I – on p 1, part II – on p 31, part III – on p 147). Once again, you will notice that each part covers various topics and refers to the applicable chapter in the prescribed book. Each title page also contains a breakdown of the topics themselves into one or more study units. Topic 1 – study units 1 and 2; topic 2 – study unit 3; topic 3 – study units 4 and 5; topic 4 – study units 6 and 7; topic 5 – study unit 8; topic 6 – study units 9 and 10; topic 7 – study units 11 and 12; topic 8 – study units 13 and 14; topic 9 – study unit 15 and topic 10 – study unit 16. On page viii in the “Module MNO3701 framework”, there is a diagrammatic representation of the MNO3701 syllabus, which consists of three parts, 10 topics, 16 study units and references to the relevant chapters of the prescribed book.
- Step 3: Begin with the first topic in part I by reading its title page, the topic aim and the learning outcomes for this topic. The learning outcomes indicate what you should be able to do after you have worked through the topic. The outcomes will amount either to knowing or understanding some portion of the theory or to demonstrating that you can apply your new-found knowledge to solving practical problems.
- Step 4: You are now ready to start your actual in-depth study of study unit 1. Read through the contents of the first study unit under the heading “Getting an overview”. This will indicate the learning outcomes for the particular study unit in the specific topic and what these learning outcomes entail.
- Step 5: Read through the contents under the next heading “Introduction in the prescribed book”, which will refer you to the chapter summary at the end of the applicable chapter in the prescribed book. Having obtained a good idea of what you will be expected to know, understand or achieve (ie the learning outcomes) and after reading through the applicable chapter in the prescribed book, you should be able to continue with your in-depth study of study unit 1. Start with the first portion of the study material and complete activity 1.1. The first activity

of a study unit will always place the theme you are about to study in the context of the business environment.

- Step 6: Continue with the first study unit by completing the remainder of the activities (ie 1.2, 1.3, 1.4, etc) that follow the second activity referred to in step 5. These activities will focus specifically on one or more portions of your prescribed book. Note that feedback is given at the end of each activity and may contain either detailed explanations or general comments only.
- Step 7: Once you have completed all the activities in the study unit, you will come to the heading "Check list" in the study guide. This check list contains a list of the things you should be able to do after working through the study unit.
- Step 8: Read the "Summary" at the end of the first study unit in the study guide and answer all the questions included under the heading "Assessment". After you have completed this step, you should have acquired a good knowledge of the contents and mastered the skills necessary for this part of the study material. The new knowledge you have attained and the skills you have mastered, coupled with your appreciation of the relative importance of the content of the study material, should add value to your career development. At this stage, you need to ask yourself, "Has this occurred?"
- Step 9: Repeat steps 3 to 8 for all topics (and the study units) of part I.
- Step 10: Repeat step 9 for all topics and study units of part II and part III.











We wish you well with your studies!!

PRESCRIBED BOOK

The prescribed book for this third-level module, MNO3701, is the same book prescribed for the second-level module, MNO2601:

Pycraft, M, Singh, K, Pihlela, K, Slack, N, Chambers, S & Johnston, R. 2010. *Operations management*. Second edition. Cape Town: Pearson Education. ISBN 978 177025 5630

ICONS USED IN THIS STUDY GUIDE AND WHAT THEY MEAN

Icon	Description
	Activity. This icon shows you the activities that you must do in order to develop a deeper understanding of the learning material.
	Assessment. This icon indicates that you are required to test your knowledge and understanding of the material, and demonstrate the ability to apply your knowledge in a work situation.
	Checklist. After completion of a particular study unit, you should confirm that all learning outcomes were in fact achieved and that you comply with the assessment criteria.
	Feedback. This icon indicates that you will receive feedback on your answers to the self-assessment activities.
	Key concepts. This icon draws your attention to certain keywords or concepts that you will encounter in a topic or study unit.
	Learning outcomes. This icon indicates which aspects of the particular topic or study units you have to master.
	Mind map. Mind maps illustrate relationships between various parts of the learning material.
	Read. This icon directs you to read certain sections of the prescribed books for background information.
	Study. This icon indicates which sections of the prescribed book or the study guide you need to study and internalise.
	Summary. This section provides a brief summary of what was covered in a particular study unit and what can be expected in the following study unit(s).

MODULE MNO3701 FRAMEWORK

PART I	DEVELOPING PRODUCTION AND OPERATIONS MANAGEMENT STRATEGIES FOR COMPETITIVE ADVANTAGE
Topic 1: The strategic role and objectives of production and operations management	Study unit 1: Effective production/operations management: a review (Chapter 1)
	Study unit 2: The strategic role and performance objectives of the production and operations function (Chapter 2)
Topic 2: Production and operations management strategies	Study unit 3: Developing production and operations management strategies (Chapter 3)
PART II	DESIGNING, PLANNING AND CONTROLLING THE PRODUCTION/OPERATIONS MANAGEMENT SYSTEM FOR WORLD-CLASS PERFORMANCE
Topic 3: Process technology	Study unit 4: The general nature of design in operations: a review (Chapter 4)
	Study unit 5: Utilising process technology in operations (Chapter 8)
Topic 4: Material requirements planning	Study unit 6: General nature of planning and control in operations: a review (Chapter 10)
	Study unit 7: Enterprise resource planning (Chapter 14)
Topic 5: Just-in-time planning and control	Study unit 8: Lean operations and JIT (Chapter 15)
Topic 6: Quality planning and control	Study unit 9: Assuring quality in production and operations management systems (Chapter 17)
	Study unit 10: Statistical process control (SPC), Six Sigma and acceptance sampling (Chapter 17)
Topic 7: Material requirements planning	Study unit 11: Project planning and control (Chapter 16)
	Study unit 12: Network analysis (Chapter 16)
PART III	IMPROVING THE PRODUCTION AND OPERATIONS MANAGEMENT SYSTEM FOR THE EMERGING CHALLENGES OF THE 21ST CENTURY
Topic 8: Measuring performance and improving the production and operations management system	Study unit 13: Production and operations management improvement (Chapter 18)
	Study unit 14: Total quality management (Chapter 20)
Topic 9: Maintaining the production and operations management system	Study unit 15: Failure prevention and recovery (Chapter 19)

<p>Topic 10: New challenges to and contemporary issues in production and operations management</p>	<p>Study unit 16: The production and operations management challenge (Chapter 21)</p>
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IMPORTANT PRACTICAL ELEMENTS/CALCULATIONS IN MNO3701 IN PREPARATION FOR THE EXAM:

- Master production schedule – study unit 7
- Materials requirements planning – study unit 7
- Statistical process control – study unit 10
- Network analysis (CPM) – study unit 12

MODULE AIM

The aim of this module is to provide you with knowledge and understanding of the theoretical concepts and practical skills involved in the strategic role of production and operations management (POM). This module focuses on strategies for competitive advantage, design, planning, control and improvement of the production and operations management system.

MODULE OUTCOMES

Once you have worked through this module, you should be able to

- explain the strategic role of POM in businesses, organisations and other institutions
- explain certain aspects involved in the design of the POM system and demonstrate their practical application
- describe certain aspects involved in the planning and control of the POM system and demonstrate their practical application
- describe certain aspects involved in improving the POM system and demonstrate their practical application
- anticipate the occurrence of new challenges and contemporary issues in production and operations management, and grasp the implications of such challenges and issues

PART I

DEVELOPING PRODUCTION AND OPERATIONS MANAGEMENT STRATEGIES FOR COMPETITIVE ADVANTAGE

TOPIC 1

THE STRATEGIC ROLE AND OBJECTIVES OF PRODUCTION AND OPERATIONS MANAGEMENT

AIM

To provide an understanding of the strategic role and performance objectives of production and operations management and why these are important to the business



LEARNING OUTCOMES

When you have worked through this topic, you should be able to do the following:

- explain what operations management entails in terms of the operations function, operations managers and a broad definition of operations in business
- explain why and how the production and operations function should interact with other functions in business
- explain what the main components of the transformation process model are and demonstrate, in practice, how each component differs for various types of operation
- explain the three levels of operations analysis and their relevance to all parts of the business and business processes
- distinguish between different process characteristics and demonstrate how different practical examples of operations would compare if the measures referred to above were applied
- list the activities of production/operations management and explain how the general model of production/operations management is constituted
- explain the strategic role of the production and operations function in a business and judge the contribution of the production and operations function in performing this strategic function
- explain the five main performance objectives of the production and operations function and how they can contribute to achieving production or operations-based advantages
- use your knowledge of, and insight into, the
 - interaction between the production and operations function and other business functions
 - general model of production and operations management
 - strategic role of the production and operations function in a business and the contribution of the production and operations function to a business
 - performance objectives of the production and operations function

Study unit 1

EFFECTIVE PRODUCTION/OPERATIONS MANAGEMENT: A REVIEW



KEY CONCEPTS

production/operations function	levels of operations analysis
production/operations managers	supply network
broad definition of operations	internal supplier
operations in the organisation	internal customer
core organisation functions	hierarchy of operations
organisation support functions	business processes
operations management in the smaller organisation	characteristics of operations processes
operations management in the not-for-profit organisation	the four V's of operations
inputs and outputs	volume of output
material inputs	variety of output
customer inputs	variation in demand for output
transformed resources	degree of visibility of customers
information inputs	the activities of operations management
transforming resources	the importance of operations management
outputs of goods and services	facilitating products
managing processes	the new operations agenda
general model of operations management and operations strategy	how operations can affect profits

There is a fundamental reason for reviewing material. In our case, this review includes a review of some study material already covered in MNO2601. Reviewing some headline news of a year ago is of little real use because, by its very nature, this news is “perishable” or “immediately outdated” (although we can, perhaps, use it to learn from past mistakes). On the other hand, a review of the study material will benefit you directly and indirectly because doing so

- will remind you of ideas, concepts, methods, techniques and so on that you may have forgotten
- will provide you with essential background information for further discussion of topics previously covered and will provide you with a starting point for examining new topics
- will help you to understand the study material by familiarising you with the same method and/or structures of the study material used previously
- prevents confusion (by placing “new” knowledge and/or application skills within the context of the subject field under examination)

In short, there is real value in reviewing some of the study material we have covered in the past. In fact, let us start again – at the beginning.

GETTING AN OVERVIEW

In this study unit we will cover the first six learning outcomes of topic 1. We will look at what effective production/operations management entails; consider why operations management is regarded as important; discuss the main components of the transformation model and the measures used to distinguish between different types of operation; discuss the direct and indirect responsibilities and the broader operations responsibility of operation managers; and, finally, discuss a general model of production/operations management.

1.1 INTRODUCTION IN THE PRESCRIBED BOOK



READ

First read the introduction to chapter 1 in your prescribed book and note the basic composition of figure 1.8. This figure shows a general model of production/operations management. You need to memorise this figure because it serves as a mind map for the remainder of the module. Once you have done this, read the four main questions and the answers in the summary answers to the key questions at the end of chapter 1.

1.2 PRODUCTION/OPERATIONS MANAGEMENT

Production and operations management centres on the transformation process model (figure 1.2) and it is an activity that involves managing resources which are devoted to the production and delivery of products and services. The following activities will help to establish a good foundation for what production and operations management entails.



ACTIVITY 1.1

Read the case study of IKEA in chapter 1 of your prescribed book and then answer the following questions:

- (1) What is/are the outstanding performance area(s) in which IKEA excels?
 - (2) With specific reference to the definitions of the operations function, operations managers and operations management given in chapter 1 of your prescribed book, what outstanding performance do you think originates from the production/operations function?
-



FEEDBACK: ACTIVITY 1.1

- (1) *You could have identified many areas in which IKEA excels, such as its concern for value for money and affordability and its knowledge of its market.*
- (2) *Given that you are now studying production/operations management (POM), the second question of this activity focuses on this subject field of specialisation. Production/operations-based areas that you might have identified include the following: location*

of its stores (outside the city centres), the design, layout and organisation of its stores, as well as its genuine concern for shoppers' "peace of mind" (indicated by the provision of supervised children's play area, etc).



ACTIVITY 1.2

Study the first section of chapter 1 in your prescribed book, entitled "What is operations management?" and then answer and/or complete the following:

- (1) The production/operations function is devoted to
 - (2) Production/operations managers have a specific responsibility for
 - (3) Production/operations management function is central to the organisation because
 - (4) The broad definition of production and operations management is
 - (5) Why do all businesses need production and operations management (POM)?
 - (6) Distinguish between inputs and outputs of the transformation process model.
-



FEEDBACK: ACTIVITY 1.2

- (1) Questions 1, 2 and 3. We suggest that you consult the relevant pages in your prescribed book where the authors discuss the basic definitions of the following three concepts: operations function, operations managers and operations management. Also, we suggest you page ahead in chapter 1 of your prescribed textbook to the subsections entitled: "Operations management is about managing processes" and "Operations management is relevant to all parts of the business". These also provide an explanation of "operations as a function" and "operations as an activity".
- (2) Question 4. The broad definition of production and operations management is very simply the activities necessary to fulfil customer requests. A detailed definition may include the following aspects: production and operations management deals with the specialist field in a business organisation that is primarily responsible for managing the conversion processes (also referred to as the transformation processes) whereby goods (or products) are manufactured and/or services are provided. A business will, in all probability, be unable to manufacture products and/or provide services which meet the specific operations-based requirements (in terms of low cost, high quality, dependability, flexibility and speed) of its customers and/or clients unless the people running the business have a reasonable knowledge of the internal workings of POM (bear in mind that any business consists of interrelationships between its different functional components).
- (3) Question 5. All organisations need production and operations management. This is because they all have a function that is specifically responsible for manufacturing the products and/or rendering the services that the organisation (be it a profit-making or non-profit-making organisation) hopes to deliver in its attempts to satisfy the needs of its customers or clients.
- (4) Question 6. The inputs and outputs of the transformation process model are described in the textbook by using figure 1.2. The goal is to manufacture goods (products) and/or provide services that will satisfy the needs of the customers or clients of the business in a way that it is able to make money (or more directly stated: show a profit). Let us focus on the key issues of this goal. (Note: these issues are not necessarily presented in the exact order of their importance.)

- (a) *The issues of the POM goal deal with the primary function in a business, that is, it is responsible for managing all the activities and different steps needed to physically manufacture the product (a chair, a motor vehicle, a fridge, etc) or to actually provide the service (legal advice and representation, postal delivery, a haircut, etc). The essence of this issue is thus the management of the production/operations function. If this function is not managed well (in terms of both efficiency and effectiveness), the inevitable result is usually either a partial or even a total business failure. Failures that typically stem from the production/operations function include*
- *unreliable operation (high level of breakages or unpredictable delivery)*
 - *inflexibility (the business cannot respond to demands such as a need to change product features, or changes in volume or delivery processes)*
 - *poor quality (non-compliance with product specifications or discourteous, inefficient service)*
 - *slow response time (non-availability of products or long queuing lines)*
 - *high production/operation costs (unrealistically high product prices, uninterested customers/clients and loss of market share) – as affected by all the failures mentioned previously*
- (b) *It implies that the products that are manufactured or the services provided must satisfy the specific and/or actual needs of the customers or clients. The essence of this issue is thus the needs of customers or clients of the business. If products are made or services are provided that do not meet the requirements of the market, the business will suffer consequences similar to those described above. From a production/operations management viewpoint, customers' or clients' needs may be expressed in "performance objectives". These were referred to previously, when we discussed the possible reasons for partial or total business failure (ie the need for high dependability, flexibility, quality, fast speed and low costs).*
- (c) *This is the essence of a business as we know business in western style free-market economies; the goal is to conduct all production/operations activities in a way that enables the business to make money or realise a profit. In any business there are, obviously, many stakeholders who have an interest in the long-term growth and survival of that business. A few groups of stakeholders that come to mind are the owners of the business (or the shareholders, if it is a company), the employees or personnel, the customers or clients and, in a broader context, the community at large. It should be noted that, while each stakeholder group may have somewhat different interests (the owners envisage an acceptable return on their investment, the employees earn a salary and hope to have a stimulating career, the customers and clients have certain needs and the community at large demands a responsible approach to the way the business conducts its activities in terms of the environment, community involvement and employee empowerment, etc), none of these aims can be achieved if the business is continually losing money and ends up having to close its doors.*

1.3 PRODUCTION AND OPERATIONS MANAGEMENT IS ABOUT MANAGING PROCESSES



ACTIVITY 1.3

Study the sections in chapter 1 of your prescribed book entitled “Operations management is about managing processes” and “Operations processes have different characteristics” and then answer the following questions:

- (1) The mechanisms that transform inputs to outputs are called processes. How can operations be analysed and what are the three levels of operations analysis?
 - (2) Is it true that all functions manage processes? Can all managers be regarded as production and operations managers? Discuss this aspect in the context of operations as a function, operations as an activity and the entire business as a process.
 - (3) Operations differ in a number of ways. You may think of ways in which processes differ in size, complexity and level. This section, however, identifies four different characteristics. Explain these four “Vs”.
 - (4) Explain the implications of the four Vs by means of figure 1.6.
-



FEEDBACK: ACTIVITY 1.3

Production and operations management centres on the transformation process model (figure 1.2). Process management is inherent in production and operations management. Besides the types of operations system (job operation, batch operation, etc), we also need to understand the hierarchy of operations as well as to analyse operations at three levels, namely, the supply network, the operation and the process. Study table 1.3 in order to describe operations in terms of their processes. This view of operations will clearly show that production and operations management is relevant to all parts of the business. Each process fulfils internal and external customer needs and it is important to constantly improve these processes. To reorganise process boundaries and organisational responsibilities around these business processes is the philosophy behind business process re-engineering (BPR). Some processes have a high level of output with low variety, while others produce a high variety and so forth. These are some of the ways in which processes behave as explained in terms of the four Vs.

1.4 THE ACTIVITIES OF OPERATIONS MANAGEMENT



ACTIVITY 1.4

- (1) Broadly speaking, what are the various activities that the different functions of various organisations carry out in conjunction with the production/operations function?
- (2) Why is production and operations management so important? Why is it said that the production/operations function occupies a central position in the organisation (or business)? Distinguish between the so-called “core” and “support” functions of a business/organisation.
- (3) What does the so-called “new operations agenda” entail and how does the advent of increased globalisation of production/operations networks, new internet-based

technologies, the supply chain perspective and the notion of “lean” operations add to the new pressures placed on the production/operations function?

- (4) Some refer to operations as the engine of the business. Without this “engine” a business cannot exist. Indicate how important operations are and specifically show how operations affect profits.
-



FEEDBACK: ACTIVITY 1.4

The general list of activities of operations management defines the boundaries of the production and operations management function. This also emphasises the importance of production and operations management in terms of its key role in the organisation (eg in terms of revenue, costs, profits, investment and innovation). It should be noted that the items in the list of the so-called “new operations agenda” in table 1.5 is not necessarily complete and/or relevant to all types of business/organisation. Different companies in different industries may need to respond to different pressures brought about by changes in the various business/organisational environments. One thing, however, that would hold true for all is that the business/organisation environments are definitely more complex and changing more rapidly than ever before.

1.5 THE MODEL OF PRODUCTION AND OPERATIONS MANAGEMENT



ACTIVITY 1.5

Study figure 1.8 and answer the following questions:

- (1) How does this model relate to figure 1.2?
- (2) All the operations activities in the model define production and operations management and operations strategy. What are the two combined ideas used to develop the model of production and operations management?
- (3) What are the main components of the general production/operations management model?
- (4) What do the linking arrows and interconnected loops between the various components of the general production/operations model signify?
- (5) How true is the following statement? Nothing and nobody exists in isolation. This is also true of the production/operations function in a business organisation. Production/operations is/are responsible for, and primarily involved in, the production of products and services. Each of the other business functions also has a similar responsibility and primary involvement in the business organisation. Marketing researches its customers’ or clients’ needs, determines pricing policies, decides on the physical distribution or place where it will market its products/services, and promotes (this includes advertising) the business’s products/services. The financial function is responsible for all the financial and accounting activities, including the preparation of yearly financial statements and budgets, paying suppliers, creditors and employees, collecting income from sales and debtors, managing cash flow, considering and looking after fixed investments and generally establishing and maintaining the sound financial position of the business. The personnel or the human resource function is responsible for all aspects directly related to the recruitment, training, appraisal, and suchlike of staff or employees. The purchasing function is responsible for the procurement of

all materials, consumables and equipment, including developing reliable supplier relationships. Please note that the list of responsibilities and areas of involvement of the other business functions mentioned above is by no means complete. Not only are there many other areas of involvement not listed, but the exact breakdown of the different functional responsibilities differs significantly from one business to another. Our concern in this module, however, is the production/operations function.



FEEDBACK: ACTIVITY 1.5

- (1) Question 1. When we combine the transformation model and the activities of production/operations management, we are in a position to suggest a general production/operations management model that can be broadly applied to any type of organisation.
 - (2) Question 2. The first is the input–transformation–output model and the second is the categorisation of production and operations management’s activity areas.
 - (3) Question 3. Figure 1.8 describes the main components.
 - (4) Questions 4 and 5. It should be noted that the various linking arrows and interconnected loops in the production/operations management model signify the flow of information between the constituent parts. For example, the arrows that link the direct responsibility activities of design, planning and control, and improvement more or less represent the chronological sequence in which these activities are carried out. The arrows and interconnected loops that link the production/operations strategy and the design and improvement activities signify the need for interaction and information flow between these components. Similar observations could be made of all other linking arrows and interconnected loops. Remember, we are visually portraying the components (and interaction among them) of a system, in this case, a production/operations system. Note also that the two interconnected loops between the bottom and top portion of the model represent the subject fields of production/operations management (bottom loop) and production/operations strategy (top loop). Finally, take note of the critical commentary made by the authors of your prescribed textbook regarding the suggestion that all businesses/organisations have broadly similar operation processes and all produce products and services which are essentially similar. Question 5 refers to a very true statement that explains how integrated production and operations management is with regard to the entire business.
-

As a general point on the review of topic 1, should you feel that there is insufficient information to answer the questions properly or if you realise that you do not understand or remember one or more sections (ie definitions, concepts, practical applications, models, etc) of the study material contained in this chapter, we urge you to go back to topic 1 of module MNO2601. We say this because module MNO3701 builds on the knowledge and skills you should have acquired when studying the second-year module, MNO2601.



CHECK LIST

Now that you have completed study unit 1 on effective production/operations management, you should be able to do the following:

- (1) Explain what production/operations management in the business/organisation entails in terms of its responsibility, operations function and the broad definition of operations.
- (2) Explain the relationship between the production and operations management function and other core and support functions of the organisation.

- (3) Explain what the main components of the transformation process model are and demonstrate, in practice, how each component differs for various types of operation.
- (4) Distinguish between the three levels of operations and explain each level.
- (5) Explain the statement that all functions of the organisation manage processes and that production and operations management is therefore relevant to all parts of the business.
- (6) Explain the various characteristics of operations processes and the four important measures used to distinguish between different types of operation and demonstrate how different practical examples of operations compare if the measures referred to above were applied.
- (7) To understand the responsibility of the operations function, one needs to understand the activities of production and operations management – list six “general classes of activities” and use these to explain why production/operations management is regarded as important.
- (8) Illustrate and explain how the general model of production/operations management is constituted.
- (9) Use the knowledge, insight and skills you have attained of (1) what production and operations management entails; (2) production/operations management is about managing processes; (3) the main components of the transformation model; (4) the characteristics/dimensions/measures used to distinguish between different operations processes; (5) the activities of production and operations management; and (6) the general model of production/operations management, to justify its relevance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications in general and answer multiple-choice or essay questions.



SUMMARY

You should now hopefully have a better understanding and even appreciation of POM and the importance of production/operations management in all types of business/organisation.



ASSESSMENT

- (1) Complete study activities 1, 2 and 3 at the end of chapter 1 of your prescribed book.
Note: Some study activities may require you simply to reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation or other institution. Some activities may even require that you visit a local business/organisation or other institution to investigate an aspect of this subject for yourself.
- (2) Study the example of Greenside High School – operational leadership and accountability in chapter 1 of your prescribed book and draw a four Vs profile of the company's products/services.
- (3) Study figure 1.8 in your prescribed book and make sure you understand the chapter sequence and structure of the textbook.
- (4) You have to assess yourself by means of the five activities (activity 1.1 etc.) in this study unit, the check list with nine questions or learning outcomes, and the additional

recommended assessment activities provided. This will enable you to answer similar and any related questions on the NQF level of this module.

Study unit 2

THE STRATEGIC ROLE AND PERFORMANCE OBJECTIVES OF THE PRODUCTION AND OPERATIONS FUNCTION



KEY CONCEPTS

driving the business strategy	internally supportive
Hayes and Wheelwright's four-stage model	externally supportive
speed objective	dependability
implementing the business strategy	supporting the business strategy
increasing contribution	product/service flexibility
five performance objectives	mix flexibility
role of production and operations function	delivery flexibility
the cost objective	volume flexibility
the quality objective	mass customisation
the speed objective	agility measure of performance
flexibility objective	productivity measure of performance
internal neutrality	polar representation of performance objectives
external neutrality	

GETTING AN OVERVIEW

This study unit covers learning outcomes 7 and 8 of topic 1. In this study unit, we will discuss the strategic role of the production and operations function in a business and judge its contribution to the organisation. We will also look at the performance objectives of production/operations management and the extent to which they contribute to achieving “production/operations-based advantages”.

2.1 INTRODUCTION IN PRESCRIBED BOOK



READ

First read the introduction to chapter 2 in your prescribed book. Note the basic composition of figure 2.1, which depicts a general model of production and operations management and highlights the specific aspect of the model that the authors will examine. Read the two points under the question: “What role should the operations function play in achieving strategic success?”, and “What are the performance objectives of operations and the internal and external benefits that derive from excelling in each of them?”

2.2 THE STRATEGIC ROLE OF THE PRODUCTION AND OPERATIONS FUNCTION



ACTIVITY 2.1

Read the case study on “XPS-delivery service” in chapter 2 of your prescribed book and then answer the following question:

- (1) Who are the stakeholders of XPS delivery service and what are the concern(s) of each group?
-



FEEDBACK: ACTIVITY 2.1

- (1) Question 1. The discussion in your prescribed book clearly identifies five groups of stakeholder: customers, suppliers, shareholders, employees and society at large. Each group has different concerns but, collectively, all these concerns are very relevant to the company's long-term prospects or outlook. However, we would caution against any one group “hijacking” the business/organisation by recklessly pushing its own agenda – this would only be to the detriment of the business/organisation as a whole. We still believe that the “customer/client is king” and, indeed, is the very reason for the organisation's existence.
-



ACTIVITY 2.2

Study the first section of chapter 2 entitled “The role of the operations function” in your prescribed book and then answer and/or complete the following:

- (1) In the simplest terms, the role of the marketing function is to; the financial function to; and the production and operations function to
 - (2) The production and operations function has three possible roles to play in a business. What are these roles?
 - (3) Are the three roles that the production and operations function can play in a business mutually exclusive? (That is, can this function fulfil all three roles at the same time?)
 - (4) In terms of the “Four-Stage Model” (developed initially by Professors Hayes and Wheelwright and later added to by Professor Chase), which traces the progression of the production and operations function of a business and its competitiveness, stage 1 comprises a state of internal neutrality, which means, stage 2 of external neutrality, which means, stage 3 of internal support, which means and stage 4 of external support, which means
 - (5) Is there a connection (and if so, what is the connection) between the three strategic roles of the production and operations function and the progressive stages of development of the function and its competitive role and contribution to the business?
 - (6) Draw a diagrammatic representation of the Four-Stage Model that clearly indicates how the production and operations function can increasingly contribute to the competitive ability of the business/organisation.
 - (7) How are “production and operations-based” advantages created and why are they important?
-



FEEDBACK: ACTIVITY 2.2

- (1) Questions 1 to 3. We should note that the three roles that the production and operations function may play in a business (namely that of a supporter, an implementer and a driver of the business strategy) are not mutually exclusive. For a business to be truly competitive, the function must fulfil all three roles. It must support the business strategy by developing appropriate objectives and policies for the resources it manages, it must translate strategic decisions taken at overall company level into practical reality, and it must provide the means for the business to achieve a competitive advantage. Note the newspaper extracts illustrated in figure 2.2 of your prescribed book, where even some of the best known companies were let down by their operations.
 - (2) Questions 4 to 6. The Hayes and Wheelwright Four-Stage Model is illustrated in figure 2.3 of your prescribed book. Note how the increased contribution and competitive role of the production and operations function are defined from stage 1 to stage 4 by the phrases "stop holding the organization back" (previously in the first edition of the prescribed book labelled as "stop making mistakes"), "be as good as competitors" (previously in the first edition of the prescribed book labelled as "being among the best"), "be clearly the best in the industry" (previously in the first edition of the prescribed book labelled as "being clearly the best") and, finally, the ultimate aspired position to "redefine the industry's expectations" (previously in the first edition of the prescribed book labelled as "sustaining superiority through production or operations-based advantages"). However, note the critical commentary by the authors of your prescribed book regarding stage 4 of the model and the needs of the market. Do you agree with their remarks?
-

2.3 PRODUCTION AND OPERATIONS PERFORMANCE OBJECTIVES



ACTIVITY 2.3

Study the second section of chapter 2 in your prescribed book entitled "Operations performance objectives" (this section was previously also covered in our second-year module, MNO2601) and then answer and/or complete the following:

- (1) The five performance objectives for production/operations management are as follows
 - (a) Quality, which means
 - (b) Speed, which means
 - (c) Dependability, which means
 - (d) Flexibility, which means
 - (e) Cost, which means
- (2) What effect could the achievement of the five performance objectives have on gaining a production/operations-based advantage for each of the following types of operation: a hospital, an automobile plant, a bus company and a supermarket?
- (3) What do each of the following performance objectives of production/operations management entail and how would achieving these objectives (quality, speed, dependability, flexibility and cost) benefit the external and internal customers/clients of the operation?
- (4) Why is a distinction drawn between product/service, mix, volume and delivery flexibility? What does mass customisation entail?

- (5) What are the external and internal effects of the five performance objectives and why would cost influence all other performance objectives?
 - (6) What other measures of operations performance can be identified and how can they be used to judge an operation's performance?
 - (7) How can a polar representation of the performance objectives help to illustrate the relative importance of each objective (required performance) and assess the operation's actual performance against each objective?
-



FEEDBACK: ACTIVITY 2.3

- (1) Question 1. Note the basic description and explanation of the advantage that may be achieved by each under the heading "The five performance objectives" in chapter 2 of your prescribed book.
- (2) Question 2. Study the various illustrations for each of the performance objectives for a hospital, a bus company, an automobile plant and a supermarket in chapter 2 of your prescribed book (the quality objective – figure 2.4; the speed objective – figure 2.5; the dependability objective – figure 2.6; the flexibility objective – figure 2.7; the cost objective – figure 2.8).
- (3) Question 3. Consult the discussions under each of the subheadings for the five performance objectives in chapter 2 of your prescribed book. Also read the case studies on each and answer the questions set at the end of each case study (quality – "Farm productivity"; speed – "When speed means life or death"; dependability – "Taxi wars"; flexibility – "Flexibility and dependability in the newsroom"; cost – "The mini-supermarkets debate").
- (4) Question 4. The performance objective of flexibility for customers/clients means that the operation must be able to change to meet four types of requirements: product/service (new or modified products/services); mix (wide range of products/services); volume (different quantities of products/services over time); and delivery (timing of delivery of products/services). Mass customisation means both variety (usually obtained at a higher cost with low volume) and high volume of products/services. Products/services are customised for individuals, but high volumes are achieved through mass production. Is mass customisation possible at Unisa?
- (5) Question 5. Note that, while all individual performance objectives will have external and internal benefits if they are achieved – see figure 2.9 in chapter 2 of your prescribed book – cost is also collectively influenced by achieving all other performance objectives within the operation. Error-free processes (higher quality), fast throughput (greater speed), reliable operations (higher dependability) and the ability to change quickly (greater flexibility) all have the potential to improve total profitability by lowering costs.
- (6) Question 6. Other combined measures (measures which are a combination of quality, speed, dependability, flexibility and cost) may be used to judge the operation's performance. A passion or focus on the wellbeing of the internal customer may put the focus on "safety" especially in mining operations where cost and productivity is linked to safe operations.
- (7) Question 7. Study figure 2.10 in chapter 2 of your prescribed book. The zero level point for each performance objective is in the centre of the diagram, while the required level of performance is denoted by the distance from the centre. Effectively, the further away from the centre point a particular performance objective, the higher its relative importance. Both a higher and lower actual performance of the operation against the required particular performance objective should be investigated to find the root causes for the "better" or "worse" performance.
- (8) To summarise: note that, while all performance objectives will individually have both external and internal benefits if they are achieved, the overall result of attaining these objectives is to save money. Cost is also collectively influenced by the improvement of

all other performance objectives within the operation. Error-free processes (better quality), faster throughput (greater speed), reliable operations (higher dependability) and the ability to change quickly (greater flexibility) all create the potential to improve the organisation's total profitability by reducing costs.



CHECK LIST

Now that you have completed study unit 2 on the strategic role and objectives of the production and operations function, you should be able to do the following:

- Explain what the strategic role of the production and operations function in a business is and how the contribution of the production and operations function can be judged.
- Explain what the performance objectives of the production and operations function are and how they can contribute to achieving “production or operations-based advantages”.
- Use your knowledge of, and insight into
 - the strategic role of the production and operations function in a business and the contribution of the production and operations function
 - the performance objectives of the production and operations function

to explain the importance of the above mentioned 2 points and to show that you understand this by answering either multiple-choice or essay-type questions based on the study material and its practical application.

- Demonstrate your appreciation of the strategic role and performance objectives of the production and operations function by explaining the theoretical concepts and demonstrating that you know how to apply the relevant production and operations skills in practice.



SUMMARY

Apart from the activities, tasks and responsibilities normally associated with the production and operations function, the production and operations function also fulfils the three major strategic roles of supporter, implementer and driver of the business strategy. The extent of the POM's contribution to a business's competitiveness depends on the degree to which the organisation or business allows it to fulfil its potential. The five basic performance objectives of quality, speed, dependability, flexibility and cost apply to all operations and achieving these objectives is the key to a business gaining and sustaining “production or operations-based” advantages which are critical for its long-term survival and success.



ASSESSMENT

- (1) Read the case study entitled “Operations objectives at the Penang Mutiara” at the end of chapter 2 of your prescribed book and answer the questions at the end of the case study.
- (2) Study the worked-out example of the environmental services department in chapter 2 of your prescribed book and see whether you agree with the polar diagram for NC and GR service as illustrated in figure 2.11.

(3) Complete study activities 1, 2, 3 and 4 at the end of chapter 2 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation or other institution. Other activities may even require you to visit a local equivalent business/organisation to investigate an aspect of the subject yourself.

TOPIC 2

PRODUCTION AND OPERATIONS MANAGEMENT STRATEGIES

AIM

To provide you with an understanding of what the development of production and operations management strategies entails and why this is important for any business.



LEARNING OUTCOMES

When you have worked through this topic, you should be able to do the following:

- Describe the role that a strategy plays in the business and explain where the production and operations strategy fits into the business strategy hierarchy as a whole.
- Describe and explain what the content of the production and operations strategy entails and how it develops.
- Explain how the process of operations strategy guides the trade-offs between performance objectives.
- Use your knowledge of and insight into
 - the role that a strategy plays in a business and where the production and operations strategy fits into the business's strategy hierarchy
 - the content of the production and operations strategy
 - the process of the production and operations strategy

to explain the importance of strategy and demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications in general and answer both multiple-choice and essay questions.

- Demonstrate that you understand production and operations management strategies by explaining the theoretical concepts and demonstrating that you know how to apply the relevant production and operations skills in practice.



TOPIC STUDY UNIT

Study unit 3 Developing production and operations management strategy
(chapter 3)

Study unit 3

DEVELOPING PRODUCTION AND OPERATIONS MANAGEMENT STRATEGY



KEY CONCEPTS

strategic decisions	introduction stage
corporate strategy	growth stage
top-down	maturity stage
bottom-up	decline stage
market requirements	resource-based view (RBV)
operations resource capabilities	intangible resources
business strategy	structural operations decisions
functional strategy	infrastructural operations decisions
emergent strategy	Ps of operations strategy formulation
competitive factors	The Platts-Gregory procedure
order-winning competitive factors	performance objective
qualifying competitive factors	trade-offs
less important competitive factors	efficient frontier
competitor's influence on performance objectives	operation within an operation
product/service life cycle influence on performance objectives	
product/service life cycle	

GETTING AN OVERVIEW

This study unit covers the learning outcomes of topic 2. In this study unit, we shall discuss the role that a strategy plays in the business, where the production and operations strategy fits into the business's strategy hierarchy, and the content and process of the production and operations strategy.

3.1 INTRODUCTION IN THE TEXTBOOK



READ

First read the introduction to chapter 3 in your prescribed book. Note the basic composition of figure 3.1, which depicts a general model of production and operations management and highlights which particular aspect of the model is to be examined. Read the two points under the question: "What is strategy?", the two points under the question: "What is the difference between a 'top-down' and a 'bottom-up' view of operations strategy?", the two points under the question: "What is the difference between 'market requirements' and 'operations resource' view of operations strategy?", and the three points under the

question: "How can an operations strategy be put together?" at the end of chapter 3 in your prescribed book.

3.2 THE ROLE OF STRATEGY IN BUSINESS



ACTIVITY 3.1

Read the case study entitled "Kulula.com" in your prescribed book and then answer the following questions:

- (1) What is Kulula's business strategy?
-



FEEDBACK: ACTIVITY 3.1

- (1) Please note that, at this point, it is sufficient for you simply to be able to distinguish broadly between a corporate/business strategy (we use the two terms interchangeably here) and its accompanying functional strategies. In the case of Kulula, the overall strategy is to offer a low-cost (setting the standard for low-cost fares), no-frills air travel service.
-



ACTIVITY 3.2

Study the first section of chapter 3 entitled "What is strategy and what is operations strategy" in your prescribed book and then answer and/or complete the following:

- (1) A "strategy" is defined as
 - (2) What are the three main characteristics of strategic decisions?
 - (3) What does the distinction between the content and process of the production/operations strategy entail and why is it necessary to consider the production/operations strategy from these two points of view?
-



FEEDBACK: ACTIVITY 3.2

- (1) Question 1. We should bear in mind that while, in general, the objectives or goals of a business represent the objectives, financial and non-financial, at which all business activities are aimed (Koontz, O'Donnell & Wehrich, 1988:62), strategies in particular reflect the organisation's large-scale, future-oriented plans to optimise the achievement of these objectives (Pearce & Robinson 1985:6).
- (2) Question 2. Note the following additional aspects (other than those in your prescribed book dealing with the widespread effect they have, the definition of the position of the business relative to its environment, and the movement of the business closer to its long-term goals) of strategic decisions described by Pearce et al (1985:7–8):
 - Strategic decisions require the involvement of top-level management. These decisions typically impact on, or include, several areas of the business. At this level, there is a need to understand and anticipate the wide-ranging implications and ramifications of such decisions. Furthermore, top-level management usually has the power to authorise the allocation and deployment of resources for the implementation of strategies.

- *Strategic decisions involve the deployment of substantial resources. Human and non-human resources must either be redirected from internal sources or secured from outside the business. In either case, the decisions taken commit the business to numerous actions over a specific period.*
 - *Strategic decisions will have a significant impact on the long-term position of the business, locking the business into a particular position for an extended period of time.*
 - *Strategic decisions are future-oriented. They are made on the basis of anticipation and forecast, with the emphasis on developing projections that will enable the business to choose the most promising strategic position. There is therefore a need to adopt a proactive and anticipatory stance towards change.*
 - *Strategic decisions have major multifunctional consequences. These decisions coordinate and require the involvement of more than one functional department or division. Each of these areas will be affected by the allocation or reallocation of responsibilities and resources related to the decision.*
 - *Strategic decisions make it necessary to take into consideration the factors in the business's external environment. Business organisations are open systems which influence, and are influenced by, external conditions largely beyond their control.*
- (3) *Question 3. Note the clear distinction as explained in your prescribed book. In the context of strategic management, it is appropriate that we briefly look at the distinction proposed by Schellenberg (1983:23–28). In her comprehensive research on the issues of strategy implementation, she came across a distinction between the content and process school perspectives on both strategy formulation and implementation. Her proposal was previously used by Krüger (1994). Table 3.1 illustrates this subdivision.*

TABLE 3.1

Strategy formulation and implementation: content and process school perspectives

CONTENT	PERSPECTIVES	PROCESS
STRATEGY FORMULATION	What does the business want to do or achieve?	How did the business decide what it wanted to do or achieve? <i>(action of formulating the strategy)</i>
STRATEGY IMPLEMENTATION	What does the business have to do in order to get the strategy to become part of it or to be reflected in it?	How did the business decide what it was going to do to get the strategy to become part of it? <i>(action of implementing the strategy)</i>

In strategy formulation, the content school perspective focuses on **WHAT** the overall strategy of the business or organisation is or should be. The process school, however, is concerned with **HOW** this strategy was formulated. For instance, it analyses the strengths, weaknesses, opportunities and threats (known as the “SWOT” analysis) to determine

the appropriate strategy for the business. This process is also generally referred to as “formulating”.

However, before we continue our examination of strategy implementation, we must take note of Schellenberg’s (1983:19–21) conclusions that the focus of strategic management in the past has been almost entirely on strategy formulation; strategy implementation has been virtually ignored. She goes on to state that, while the impact of correctly formulating strategies should not be dismissed, this, by itself, is an insufficient condition for success. The strategy must be accomplished (or implemented) before the organisation’s full potential can be realised.

In the case of strategy implementation, the content school perspective focuses on what the implementation is, or on the specific design for the implementation. The design is the vehicle through which the strategy is translated into reality; the design can further be seen as the physical reflection of the formulated strategy. The three most commonly identified tools for implementation are as follows:

1. the organisational configuration or formal structure
2. the administrative systems or processes, such as budgets, reward and information systems
3. the leadership characteristics which include top-level leadership, interpersonal behaviour, participation and commitment

The process school perspective, in turn, is concerned with HOW the strategy is implemented. This perspective considers the following:

1. the cognitive (“thought”) processes of the individuals involved
2. the social and organisational processes which constrain the choice of structure, and so forth
3. the political processes through which power is used to influence the implementation

Organisational behaviour is relevant here. Organisational behaviour refers to resistance to change, management-by-objectives (MBO) and personality characteristics such as interpersonal trust and the ability to resolve conflict. This process is generally referred to as “implementing”.

With reference to Schellenberg’s (1983) distinction between the content and process school perspectives of strategy formulation and implementation, we suggest that it may also be worth considering applying the reasoning behind such an analysis to production and operations strategies. This would enable us to consider, first, the formulation of the production and operations strategy (both content and process related issues involved, that is, “What is the production and operations strategy of the business going to be?” and “How was it decided what it was going to be?”). And it would enable us to consider, secondly, the implementation of the production and operations strategy (again both content and process-related issues are involved, that is, “What will have to be done for the production and operations strategy to be accomplished/achieved in the business?” and “How was it decided what had to be done?”).

Note, therefore, that the questions listed in your prescribed book which, the authors suggest, deal with the content of production and operations strategies and the process aspects, appear to cover both the formulation and implementation of such strategies.

4. To summarise: note that, very simply, a strategy may be thought of as a “plan of action”. In our everyday lives we may be involved in planning and carrying out many different personal strategies. In all these cases, we are directed by a vision of the future we would like to create or a position we would like to be in. (We can refer to this planning activity with a particular aim in mind as “formulating a strategy”). We then think of various ways of achieving this (this activity may be referred to as “implementing a strategy”).

3.3 THE CONTENT OF THE PRODUCTION AND OPERATIONS STRATEGY



ACTIVITY 3.3

Study figure 3.2 and the following sections of chapter 3 entitled “The top-down perspective”, “The bottom-up perspective”, “The market requirements perspective” and “The operations resources perspective” in your prescribed book and then answer and/or complete the following:

- (1) What does each of the four perspectives of the production/operations strategy broadly entail?
 - (2) Explain the “top-down” perspective of the production/operations strategy and distinguish between the types of strategic decision that need to be taken at each hierarchical level.
 - (3) Explain the “bottom-up” perspective of the production/operations strategy and illustrate how so-called “emergent strategies” develop.
 - (4) Explain the “market requirements” perspective of the production/operations strategy and illustrate how the relative priority of the performance objectives are determined through (i) customer influences (competitive factors), (ii) competitor influences and (iii) product/life cycle influences.
 - (5) Explain the “operations resources” perspective of the production/operations strategy and illustrate how the resource constraints and capabilities lead to the operation’s structural and infrastructural decisions.
-



FEEDBACK: ACTIVITY 3.3

- (1) *Question 1. Figure 3.2 in your prescribed book illustrates the four different perspectives on production/operations strategy and indicates the primary focus of each. These four perspectives are the “top-down” perspective (what the business wants the operations to do); the “bottom-up” perspective (what day-to-day experience suggests operations should do); the “market requirements” perspective (what the market position requires operations to do); and the “operations resources” perspective (what operations resources can do). Note the point made by the authors of your prescribed book: none of these four perspectives on their own gives the full picture of what the production/operations strategy actually is. However, together they provide a good idea of the issues that need to be taken into consideration in forming the content of the production/operations strategy.*

- (2) Question 2. Figure 3.3 in your prescribed book illustrates the “top-down” perspective of the production/operations strategy divided into the various hierarchical levels of a corporate, business and functional strategy.
- (3) Question 3. Figure 3.4 in your prescribed book illustrates the “bottom-up” perspective of the production/operations strategy and explains the concept of “emergent strategies”.
- (4) Question 4. Note the pervasive nature of the market requirements perspective. As the authors of your prescribed book explicitly say: “without an understanding of what markets require, it is impossible to ensure that operations is achieving the right mix and level in its performance objectives (quality, speed, dependability, flexibility and cost)” (Slack et al, 2004:70). Read the case study of “Woolworths” in chapter 3 of your prescribed book and answer the questions that follow at the end of the case study.

As far as the priority of performance objectives is concerned, note the influence of customers'/clients' requirements (also referred to as “competitive factors” – see figure 3.5 in your prescribed book) by classifying them into the following categories: “order-winning factors” (factors which directly and significantly contribute to winning business); “qualifying factors” (those aspects of competitiveness which the operation has to reach if it is even to be considered); and “less important factors” (factors which are neither order-winning or qualifying). For the difference between these categories, read the case study of “Supa Kwik customers' needs”. Then answer the questions set at the end of the case study. Read the worked-out example of Khumalo and Partners Legal Services in chapter 3 of your prescribed book and note how the competitive factors shape the performance objectives of the legal firm. Finally, note that different customer/client needs imply different performance objectives, as illustrated in the example of banking services in table 3.1 of your prescribed book.

As far as competitor influence on performance objectives is concerned, note that competitor activity can influence the relative importance of performance objectives (see figure 3.7 in your prescribed book) without any change in its customers' or clients' preferences.

As far as the product/service life cycle influence on performance objectives is concerned, note that production and operations strategies (which are probably different) will be required in each stage of the product/service life cycle (introduction, growth, maturity and decline stages), as illustrated in figure 3.7 of your prescribed book.

Staying with question 4, we may note that Krüger (1996) undertook an empirical research project which examined the strategic manufacturing priorities of South African manufacturers (note that the term “strategic manufacturing priorities” means the same as the “performance objectives” described in your prescribed book). The objectives of the research were, among others: (1) to determine the extent to which certain selected strategic manufacturing priorities (SMPs) contributed to achieving and sustaining competitive capabilities and advantages; (2) to identify the current strengths and/or weaknesses in these SMPs; (3) to identify the future importance of these SMPs for effectively and efficiently competing in both the domestic economy and international marketplace; and (4) to compare the current strengths and/or weaknesses in SMPs with those that may become important for identifying areas needing improvement and/or a shift in emphasis.

The research report comprehensively documented the findings of the project. In a summary published later, Krüger (1997) reported that the majority (81%) of large South African manufacturers (those who employed more than 500 people, were located or situated in any of the geographical regions in South Africa, and which undertook manufacturing in any and all of the standard industry code [SIC] categories) acknowledged that manufacturing-based strategies enhanced firms' competitive capabilities and advantages and this contributed to long-term, superior business performance and success. An

even larger majority (98%) of firms recognised that superior manufacturing capabilities would become a prerequisite for improving both their national and international competitiveness in the future. In order to improve their position against national competitors, the mathematically derived rank order of importance (not necessarily statistically significant) for the five selected SMPs (or performance objectives) was: (1) low cost; (2) high quality; (3) high dependability; (4) high speed; and (5) high flexibility. Similarly, in the case of greater competitiveness against international competitors, the rank order of importance (again purely mathematically derived) was: (1) high quality; (2) low cost; (3) high dependability; (4) high speed; and (5) high flexibility. Note the change of position of low cost and high quality (although this was not confirmed as statistically significant) in terms of improved competitiveness between national and international competitors. Finally, when examining the rank order of importance for the SMPs for national and international competitors together, it was found (and this was confirmed statistically significant at an 0,05 level) that high quality, low cost and high dependability all ranked as priority number 1, high speed as priority number 2 and high flexibility as priority number 3.

Question 5. Note the relatively “new” influential theory of business referred to as the “resource-based view” (RBV). This theory claims that a business which has a good track record on strategic performance will have gained its sustainable competitive advantage owing to the core competencies or capabilities of its production/operations resources. Read the case study of “Flextronics – where operations strategy balances cost and service” in your prescribed book.

Furthermore, regarding resource constraints and capabilities, note the important point made by the authors of your prescribed book that no business can choose a market into which to enter without also considering its ability to produce/make products and/or serve that market. Both the transforming and transformed input resources to the operations must be taken into consideration, as should some so-called “intangible resources”. Examples here are the operation’s relationship with its suppliers and reputation with its customers/clients, the knowledge of and experience in handling process technologies, and the way its operating staff work together in new product/service development. Given this, certain decisions need to be taken which will determine the operation’s structure and infrastructure. Study table 3.3 in your prescribed book and note the typical differences in the type of decisions that influence the structure and infrastructure of an operation.

3.4 THE PROCESS OF THE PRODUCTION AND OPERATIONS STRATEGY



ACTIVITY 3.4

Study the section of chapter 3 entitled “The process of operations strategy” in your prescribed book and then answer and/or complete the following:

- (1) What does the process of production/operations strategy entail and why is it regarded as important?
 - (2) Explain the five Ps of the Platts methodology and illustrate how it can be used to formulate a production/operations strategy.
 - (3) Explain why the process of operations strategy guides the trade-offs between performance objectives.
-



FEEDBACK: ACTIVITY 3.4

- (1) Question 1. The process of formulating a production/operations strategy refers to the procedures that may be used in order to arrive at such a strategy. It differs from the content of production/operations strategy in as much as it specifies what the business will try to achieve, while the process of production/operations strategy suggests how this will be achieved.

Note the seven issues which the authors of your prescribed book (chapter 3) claim should be taken into consideration or emphasised in the process of formulating a production/operations strategy. These include the need to formally link the total business's strategic objectives to the resource level objectives, the use of competitive factors as a translation device between the business strategy and production/operations strategy, the need to judge the relative importance of the various competitive factors in terms of customer/client preferences, the need to assess the current level of achieved performance, an emphasis on the iterative cycle of the formulating process, the need to compare the current operation against an "ideal" or "greenfield" operation (starting from scratch on a greenfield), and the "gap-based" approach. The gap-based approach involves comparing what the market requires of the operation with actual achieved performance levels.

- (2) Question 2. Note the five-step procedure as described in your prescribed book. As the authors explain, this is not a simple sequential movement from step 1 to 5, but an iterative process whereby production/operations managers move from an understanding of the long-term strategic requirements of the operation and the specific resource developments which are required to support the production/operations strategy.
- (3) Question 3. The relevant strategy should address the relative priority of the operation's performance objectives. Is it possible to have speed and cost or cost and quality? The saying "there is no such thing as a free lunch" explains this approach.



CHECK LIST

Now that you have completed study unit 3 on developing production and operations management strategies, you should be able to do the following:

- Describe the role that a strategy fulfils in the business and explain where the production and operations strategy fits into the business strategy hierarchy as a whole.
- Describe and explain what the content of the production and operations strategy entails and how it develops.
- Describe and explain what the process of the production and operations strategy entails and how it is formulated.
- Use your knowledge of, and insight into
 - the role that a strategy plays in a business and where the production and operations strategy fits into the business's strategy hierarchy
 - the content of the production and operations strategy
 - the process of the production and operations strategy

to explain their importance and demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications in general and answer both multiple-choice and essay questions.

- Demonstrate your appreciation for production and operations management strategies by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



SUMMARY

Developing the production and operations strategy of a business (both its formulation and implementation) involves considering both content- and process-related aspects of the strategy itself. This, in turn, determines the relative importance or priority given to the performance objectives (as influenced by the specific needs of the business's customers/clients, the activities of its competitors and the stage in its products'/services' life cycle) for each of the three major production and operations strategy decision areas: design, planning and control, and improvement. From Krüger's research findings (1996 and 1997) on the current and future competitive position of South African manufacturers, note the very important role played by production and operations strategies in enhancing the competitive capabilities and advantages of a business and their contribution to long-term, superior business performance and success.



ASSESSMENT

- (1) Read the case study entitled "Teba Bank – the worker's bank of choice" at the end of chapter 3 of your prescribed book and answer the questions at the end of the case study.
- (2) Complete study activities 1, 2 and 3 at the end of chapter 3 of your prescribed book.

Note: some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation or other institution. Other activities may even require you to visit a local business/organisation to investigate an aspect of the subject for yourself.

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PART II

DESIGNING, PLANNING AND CONTROLLING THE PRODUCTION/ OPERATIONS MANAGEMENT SYSTEM FOR WORLD-CLASS PERFORMANCE

TOPIC 3

PROCESS TECHNOLOGY

AIM

To provide you with an understanding of what the utilisation of process technology involves and why it is important for design and for production and operations management.



LEARNING OUTCOMES

When you have worked through this topic, you should be able to do the following:

- Explain what the design activity in production/operations management entails.
- Explain the objectives of design in production/operations management.
- Explain what process design in production/operations management entails.
- Explain the different process types in manufacturing and services and justify these classifications.
- Explain what is meant by process technology in operations.
- Describe which process technology developments are currently taking place in the operations of (a) materials processing, (b) information processing, and (c) customer/client processing.
- Explain how the dimensions of automation, scale and integration of process technology could influence various types of operations and the choice of alternative technologies.
- Explain how the choice of technology should be made, given market requirements and the operations resource evaluation perspectives (including a financial evaluation).
- Use your knowledge of and insight into
 - what the design activity in production/operations management entails
 - the objectives of design in production/operations management
 - what process design in production/operations management entails
 - the different process types in manufacturing and services process technology in operations
 - which process technology developments are currently taking place in the operations of (a) materials processing; (b) information processing; and (c) customer/client processing
 - the dimensions of automation, scale and integration of process technology and their effect on the various types of operation
 - the choice of technology in view of the market requirements
 - operations resources evaluation perspectives including a financial evaluation

to explain the importance of all eight and demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study

material. You should also be able to do practical applications in general, and answer both multiple-choice and essay questions.

- Demonstrate your appreciation of process technology by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



TOPIC STUDY UNITS

- Study unit 4 The general nature of design in operations: a review
(chapter 4)
- Study unit 5 Utilising process technology in operations
(chapter 8)
-

Study unit 4

THE GENERAL NATURE OF DESIGN IN OPERATIONS: A REVIEW



KEY CONCEPTS

process design	process analysis
product/service design	process design objectives
needs of customers/clients	cycle time
throughput rate	throughput time
work content	work in process
utilisation	environmentally sensitive design
process types	volume-variety positions
project processes	jobbing processes
batch processes	mass processes
continuous processes	process types in services
professional services	mass services
service shops	product-process matrix
process mapping	process blueprinting
process mapping symbols	process variability
high-level process mapping	outline process map
Little's law	throughput efficiency
value-added throughput efficiency	simulation in design

GETTING AN OVERVIEW

In this study unit we will discuss the first four learning outcomes of topic 3. We will examine the design activity in production/operations management, the objectives of design, the different process types in manufacturing and services and process design in production/operations management.

4.1 INTRODUCTION IN THE PRESCRIBED BOOK



READ

To obtain a basic orientation to this study unit first read the introduction to chapter 4 in your prescribed book and note the basic composition of figure 4.1. This figure depicts a model of the design activities in production/operations management. You need to memorise this figure because it serves as a mind map for the remainder of the study unit. After you have done this, read the "Summary answers to key questions" namely "What is process design?", "What objectives should process design have?", "How do volume and

variety affect process design?" and "How are processes designed in detail?" at the end of chapter 4.

4.2 THE DESIGN ACTIVITY IN PRODUCTION/OPERATIONS MANAGEMENT



ACTIVITY 4.1

Read the case study entitled, "Process redesign through product redesign – a mobile telecommunications case" in chapter 4 of your prescribed book and then answer the following questions:

- (1) What are the key challenges in many telcos in terms of process design?
 - (2) How are the performance objectives of Southern Africa telcos realised through "improved" process design approaches?
-



FEEDBACK: ACTIVITY 4.1

- (1) *The high number of clients that have to be supported in countries like China and in African countries. Some telcos serve over 200 million clients in a single firm. Linked to the high volume of clients is the processing of contract upgrades at the end of contract periods. The supply of new phones as part of the contract upgrade is the norm in Southern Africa. Given the number of clients to serve, this leads to stock, logistics, security and other related challenges.*
 - (2) *Many telcos in this region have opted to give the client an alternative solution by providing him or her with a choice of device or a prepaid gift card as part of the contract upgrade. The advantage of a gift card is the flexibility associated with the card. The gift card also allows the telco variability in the design of their contracts from a financial modelling perspective and gives them speed of market entry. Stock, logistics and security issues have been replaced by simply transferring data to these cards in a batch run – a very low-cost approach. Lead time of weeks has now been turned into days.*
-



ACTIVITY 4.2

Study the following additional study material. What is your view of these design guidelines? Are they applicable or not?

The ten guidelines for effective design in operations, which Schonberger and Knod (1997:101–107) describe and categorise under three main headings, are as follows:

General guidelines

- (1) Design must take target-market expectations and target costs into account. Designers should be innovative in their search for materials and methods to ensure that the specific cost objectives of new product/service designs are met.
- (2) Minimise the number of components or operations to reduce costs, improve quality and facilitate production or service.

Quality guidelines

- (3) Ensure that customer/client requirements are precisely known so that design activities are based on actual needs. Designers should also be absolutely clear about the required specifications and tolerances.
- (4) Ensure that the available process capability is known and is sufficient to execute the design.
- (5) Use standard materials, parts, methods and procedures of known and proven quality. Untested materials and methods are risky because their performance is, by definition, an “unknown”.

Producibility/operability guidelines

- (6) Design components and service elements that are multifunctional and that can be used in different circumstances or situations.
 - (7) Design products for ease of joining, separating or rejoining and services for ease of coupling or uncoupling.
 - (8) Design for one-way assembly and one-way travel by avoiding backtracking and return visits.
 - (9) Avoid special, complicated fasteners and connectors for products and off-line services or elements that interrupt the provision of service.
 - (10) Design for robustness and avoid designs that require a great deal of care during manufacture/delivery or that otherwise encourage or allow substandard or unsafe performance.
-



FEEDBACK: ACTIVITY 4.2

It might be a good idea to identify an example of a product and a service that are well known to you and that you can closely associate with each of the individual ten guidelines for effective design. This will make the guidelines a set of practical tools for the improvement of product and service designs (rather than simply a list of theoretical concepts). Note, however, that the producibility/operability guidelines deal primarily with the aspects of product and service design that govern the manufacturing and provision processes. This again highlights the overlapping or interwoven relationship between the design of products or services and the design of their processes. See figure 4.1 at the beginning of chapter 4 in your prescribed book.



ACTIVITY 4.3

Study the first section of chapter 4 entitled “The design activity” in your prescribed book and then answer the questions and/or complete the following:

- (1) The purpose of the design activity is to
- (2) Why should the design of products and services and the design of processes for manufacture/service provision be interrelated?
- (3) What is the overriding objective for the design of processes and the design of products and services?
- (4) What is the relationship between performance objectives and design objectives? The objectives of the design activity are for designers to produce designs which are

- (a) of high quality, which means.....
 - (b) produced in a speedy manner, which means.....
 - (c) produced on a dependable basis, which means.....
 - (d) produced with flexibility in mind, which means
 - (e) produced at a low cost, which means
- (5) Environmentally sensitive design implies.....
-



FEEDBACK: ACTIVITY 4.3

- (1) Question 1. Note the “formal” definition that the authors of your prescribed book propose: “the process by which some functional requirement of people is satisfied through shaping or configuration of the resources and/or activities that comprise a product, or a service, or the transformation process that produces them.”
 - (2) Question 2. The authors of your prescribed book insist that “it would be foolish to commit the organization to the detailed design of any product or service without some consideration of how it is to be produced”. We agree with this remark. As we have emphasised before, mishaps occur because “operations-illiterate people” do not understand the importance of the product/service–process linkage. Also see figure 4.2 in chapter 4 of your prescribed book and note the overlapping area of the two circles, where it is stated that “decisions taken during the design of the product or service will have an impact on the process which produces the product or service and vice versa”. The product will determine the process and it would for instance be silly to mass produce television sets in a panel beater shop facility.
 - (3) Question 3. The overriding objective of the design activity in production/operations management is: “to provide products, services and processes which will satisfy the operation’s customers.”
 - (4) Question 4. The process must achieve something in terms of operations performance objectives (cost, speed, quality, dependability and flexibility). Table 4.1 provides a good explanation in this regard. We might also review the input–transformation–output model encountered previously in chapter 1 in terms of the design activity. Ideas, information and resources are transformed into all types of design.
 - (5) Manufacturers must be able to provide “green products” especially since environmental protection is becoming more important due to an increase in all types of pollution (water, air, noise, etc.). Designers need to consider several factors such as waste material, noise of machines/equipment and recycling possibilities.
-

4.3 PROCESS DESIGN IN PRODUCTION/OPERATIONS MANAGEMENT



ACTIVITY 4.4

Study the second section of chapter 4 in your prescribed book, entitled “Process types – the volume-variety effect on process design” and then answer the following questions:

- (1) Why do low-volume operations processes often have a large variety of products and services and why do high-volume operations processes have a narrow variety of products and services?
 - (2) Explain how the process types are used to describe different positions on the volume–variety spectrum.
-



FEEDBACK: ACTIVITY 4.4

- (1) Question 1. The specific market determines the need for a specific product/service. Products and services dictate the process type because no one type of process design is best for all types of product and service. The best way to transform inputs to outputs will give character to the process design. In manufacturing, these are to be either projects, jobs, batches, mass processes or continuous processes and in services they are professional services, service shops and mass services.
 - (2) Figure 4.3 is a good illustration of the different process types that imply different volume–variety characteristics.
-



ACTIVITY 4.5

Answer the questions and/or complete the following with reference to the section on “Process types” in chapter 4 of your prescribed textbook:

- (1) The five process types in manufacturing are
 - (a) project processes, which entail and my own three examples are
 - (b) jobbing processes, which entail and my own three examples are
 - (c) batch processes, which entail and my own three examples are
 - (d) mass processes, which entail and my own three examples are
 - (e) continuous processes, which entail and my own three examples are
 - (2) The three process types in services are:
 - (a) professional services, which entail and my own three examples are
 - (b) service shops, which entail and my own three examples are
 - (c) mass services, which entail and my own three examples are
 - (3) Some project processes are done in great volumes. Two examples are a multiple-unit project process such as a housing scheme involving the construction of 50 identical houses in nine different provinces and a shipyard where 100 identical patrol boats are built over a period of three years. Where would you place these project processes in terms of figure 4.3 in your prescribed book?
 - (4) Why do you think it is important to categorise the process types in both manufacturing and services? On what basis were these classifications made?
 - (5) What is the value of the product–process matrix illustrated in figure 4.12 of your prescribed book? Where in the matrix would you prefer to position an operation? What happens if the operation is either to the left or the right of the diagonal line?
-



FEEDBACK: ACTIVITY 4.5

- (1) Question 1. The process types in manufacturing are illustrated on the left-hand side of figure 4.3 of your prescribed book. Compare your own examples with those suggested in your prescribed book. Also note the photo example and the illustrative process flow chart for each of the process types in manufacturing (project – figure 4.4, jobbing – figure 4.5, batch – figure 4.6, mass – figure 4.7, and continuous – figure 4.8).
 - (2) Question 2. The process types in services are illustrated on the right-hand side of figure 4.3 of your prescribed book. Compare your own examples with those suggested in your prescribed book. Also note the photo example and the illustrative process flow chart for each of the process types in services (professional – figure 4.9, mass – figure 4.11, and service shop – figure 4.10).
 - (3) Question 3. We think that a multiple-unit project process could present some difficulty if we tried to position it in figure 4.3 of your prescribed book. Clearly we are dealing with a project process, but the volume is greater than one. The characteristics displayed here show lower variety but greater volume (more of a fewer variety of units) versus the “pure” project processes, which typically display high variety and low volume. Ideally, we could place the multiple-unit project process in a position similar to the batch process (ie to indicate slightly less variety and greater volume).
 - (4) Question 4. Note that similar process types can (and ought to) be managed in the same way. Conversely, different process types must (and should) be managed in a way suited to their unique operational characteristics. The basis of the classifications referred to stem from their relative position on two continuums, namely a variety and a volume continuum. The process types in manufacturing and services that have been identified display varying degrees of variety and volume characteristics. However, also note the critical remarks made by the authors of your prescribed book. The authors warn that the classifications of the process types for manufacturing and services can be considered somewhat “simplistic” because, in reality, no such clear boundaries exist.
 - (5) Question 5. The value of the product–process matrix, as illustrated in figure 4.12 of your prescribed book, lies in using it to identify the “natural” lowest cost position for an operation, namely the diagonal line. Should the operation be either to the left or right of this line, that is, either less or more process flexibility respectively, it would lead to increased cost.
-

4.4 DETAILED PROCESS DESIGN



ACTIVITY 4.6

Study the sections of chapter 4 in your prescribed book, entitled “Detailed process design” and “The effects of process variability” and answer the following questions:

- (1) How are processes designed in detail?
 - (2) What are the effects of variability in processes?
-



FEEDBACK: ACTIVITY 4.6

- (1) Question (1). The authors of your prescribed book provide an alternative definition for a process as “... a group of resources and activities which add value by turning specific inputs into outputs ...”. Furthermore, they state that, in its simplest form, the design of a process “involves identifying all the individual activities that are needed to fulfil the objectives of the process, and deciding on the sequence in which these activities are

to be performed and who is going to do them". A visual approach to process design involves process mapping (also termed "process blueprinting" or "process analysis") where processes are described in terms of how the activities within the process relate to each other. Note the examples of the symbols that can be used in process mapping (see figure 4.13 in your prescribed book). See also the difference between "high level process mapping" (see figure 4.15 in your prescribed book) and an "outline process map". The difference between these approaches is in the level of detail, which may become even more detailed. In mapping the processes it is possible to systematically focus on each and every activity (question its relevance, duration, etc) in an attempt to improve the process as a whole. See figure 4.16 of the example of a process flow chart at Intel Corporation before it was subject to a critical examination.

The importance of determining the process performance is to make sure that it is appropriate for whatever the process is trying to achieve. This can be done by assessing how good the process design is (see the example of the new customised sandwich in table 4.2 of your prescribed book) and judging its performance in terms of the "conventional" set of performance objectives. The measurement of work content (total amount of work required to produce a unit of output), throughput time (time for one unit to move through the whole process), cycle time (average time between units of output emerging from the process) and work-in-process (WIP – throughput time divided by the cycle time or time since arriving at point of the start of process until emerging from process) all provide a quantitative analysis of the performance of a particular process. The mathematical relationship that can be derived from this (throughput time = WIP cycle time or cycle time = throughput time divided by WIP, known as "Little's Law", can be used to determine the number of servers: average time in the process divided by cycle time = number of servers. Thus, if the average time a customer is in the process equals four minutes and the maximum number of customers is limited to 10, then the cycle time is 4 divided by 10 = 0,4 minutes. The number of servers needed if, on average, the time a customer is in the process is 1,2 minutes, equals 1,2 divided by 0,4 minutes = 3. Thus, 3 servers would serve three customers in 1,2 minutes. Also see the worked-out example of Little's Law in chapter 4 of your prescribed book and say whether you agree or disagree with the analysis.

- (2) Question 2. Each process behaves differently and some have more inconsistency as a result of variability. Any process is designed to be productive in terms of value adding and WIP. Certain lead time elements are unwanted such as late arrival time of units or units waiting too long to be processed or longer set-up time. There are many reasons why variability occurs in processes. All these sources of variation interact with each other, but result in fundamental types of variability such as variation in the time taken to perform the activities. The relationship between average waiting time and process utilisation is a particularly important one.



CHECK LIST

Now that you have completed study unit 4, you should be able to do the following:

- (1) Explain what the design activity in production/operations management entails.
- (2) Explain the objectives of design in production/operations management.
- (3) Explain the different process types (in manufacturing and services) in terms of the volume-variety effect on process design.
- (4) Explain detailed process design and the effects of process variability.
- (5) Use the knowledge, insight and skills you have attained through (1) what is entailed in the design activity in operations; (2) objectives of design in production/operations management; (3) what process design in production/operations management en-

tails; and (4) the different process types in manufacturing and services, to explain its importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications in general, and answer both multiple-choice format and essay-type questions.

- (6) Show evidence of your appreciation for the general nature of design in operations by explaining the theoretical concepts and demonstrating that you can apply the relevant production/operations skills in practice.



SUMMARY

Now that you are familiar with the purpose and objectives of process design in production and operations management, you will probably agree that products cannot be manufactured and/or services provided successfully if the sequence is wrong. It is necessary to start with design and taking the “real” needs of customers/clients into consideration. This study unit examined process design, while the next study unit, study unit 5, will focus in detail on utilising process technology.



ASSESSMENT

Complete study activities 1 to 4 at the end of chapter 4 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, other activities may even require you to visit a local business/organisation to investigate an aspect of the subject yourself.

SOURCE REFERENCE

Schonberger, RJ & Knod, EM Jr. 1997. *Operations management: customer-focused principles*. Sixth edition. Chicago, Ill: Irwin.

Study unit 5

UTILISING PROCESS TECHNOLOGY IN OPERATIONS



KEY CONCEPTS

process technology	indirect process technology
direct processing technology	integrated technologies
materials-processing technology	information processing
customer/client processing	materials-processing technology
computer numerically controlled (CNC) machine tools	robots
computer integrated enterprise (CIE)	automated guided vehicles (AGVs)
computer-aided design (CAD)	computer integrated manufacturing (CIM)
computer-aided manufacturing (CAM)	information technology (IT)
distributed processing	local area networks (LANs)
ethernet	integrated services digital networks (ISDNs)
world wide web (www)	extranets
m-business	e-business
decision support systems (DSSs)	management information systems (MIS)
radio frequency identification	expert systems (Ess)
customer/client-processing technology	bar code
active customer/client interaction technology	customer training
passive customer/client interaction technology	degree of automation
hidden technologies	automated technology
capital intensity of the technology	connectivity of technology
choice of technology	operations resource evaluation
financial evaluation	automatic teller machines (ATMs)the scale
time value of money	financial evaluation
discount rate	market requirements evaluation
	net present value

GETTING AN OVERVIEW

This study unit covers the fifth, sixth, seventh and eighth learning outcomes of topic 3. We shall discuss process technology in operations and current process technology developments in the operations of (1) materials processing; (2) information processing; and (3) customer/client processing. We shall also discuss the generic characteristics of process technology and the choice of alternative technologies. Finally, we shall discuss the choice of technology in view of market requirements and operations resource evaluation perspectives (which includes a financial evaluation).

5.1 INTRODUCTION IN PRESCRIBED BOOK



READ

First read the introduction to chapter 8 in your prescribed book and note the basic composition of figure 8.1. This figure depicts a model of the design activities in production/operations management. You should memorise this figure because it serves as a mind map for the remainder of the study unit. After you have done this, read the questions listed under “Summary answers to key questions” (at the end of the chapter) namely: “What is process technology?”, “What are the significant materials-processing technologies?”, “What are the significant information-processing technologies?”, “What are the significant customer-processing technologies?”, “What are the generic characteristics of process technology” and “How is process technology chosen?”

5.2 PROCESS TECHNOLOGY IN OPERATIONS



ACTIVITY 5.1

Read the case study entitled “Who’s in the cockpit?” in chapter 8 of your prescribed book and then answer the following questions:

- (1) Why do modern aircraft rely on autopilots?
 - (2) Why are autopilots not used for take-off or to perform the full range of activities from take-off, to in-air flight to landing?
-



FEEDBACK: ACTIVITY 5.1

- (1) Question 1. Note that the guiding principle in the use of autopilots lies in the objective of getting “better” performance than would otherwise be obtained (ie through human action alone). The autopilot is used in taking control of the plane during the monotonous part of the flight between take-off and landing, and to make landings safer when visibility is poor (owing to weather conditions).
 - (2) Question 2. Note that, in order to undertake auto take-off, airports and airlines would have to invest in extra guidance equipment that would be expensive to develop and install. This is because take-off is considered more complex than landing, as there is more to go wrong during take-off and any problems that do occur require split-second decision-making on the part of the pilot. Unmanned aerial vehicles (UAV) are already in use (UAVs are used for military reconnaissance). If the entire commercial flight infrastructure from air traffic control to airport control were to be restructured to wholly automatic, pilotless aircraft could be a reality. Of course, this form of flight would have to be shown as safe and passengers would have to be persuaded to fly in UAVs. However, the rewards could be substantial because commercial airlines’ largest single cost is staff wages and pilots are by far the most costly of all employees.
-



ACTIVITY 5.2

Read the first section of chapter 8 entitled “What is process technology?” in your prescribed book and then answer the questions and/or complete the following:

- (1) Process technologies are the [provide a definition].
 - (2) Provide practical examples of the range of process technologies and explain the difference between direct and indirect processing technology.
 - (3) What should production and operations managers do to manage process technology in operations effectively? Which relevant questions should they be able to answer when dealing with process technology in operations?
-



FEEDBACK: ACTIVITY 5.2

- (1) Question 1. Note the definition suggested by the authors of your prescribed book, which refers to the “machines, equipment and devices which help the operation transform materials and information and customers/clients in order to add value and fulfil the operation’s strategic objectives”.
- (2) Question 2. See table 8.1 in your prescribed book and note the various practical examples classified under the categories of materials, information and customer-processing technologies. Also read the case study of “Customers are not always human” in chapter 8 of your prescribed book and answer the questions set at the end of the case study. As far as the difference between direct and indirect processing technology is concerned, note that the first acts directly on the materials, information or customers/clients, while the latter (which is becoming increasingly important) plays a key role in facilitating the process that creates and delivers goods and services (eg an office computer system).
- (3) Question 3. Note what is involved in the management of process technology, all of which the authors of your prescribed book believe production/operations managers should be able to do. That is, visualise and explain how technology can improve the operation’s effectiveness, choose the appropriate technology, manage the installation and adoption of the technology itself, integrate technology with the rest of the operation, monitor the technology’s performance, and upgrade or replace technology. In other words, while POM managers do not have to be experts in engineering, computing, biology, electronics (or whichever is the core “science” behind the technology), they do need to know the principles behind the technology and they should be able to manage the technology in the operation as a whole. Relevant questions which POM managers should ask here centre on why a particular technology, the characteristics of the technology, the advantages of the technology, the limitations of the technology and the effect of the technology on the operation.
- (4) To summarise: note that when you think of the term “technology”, one of the first images you may visualise or things with which you may associate the term, could be a computer or – more specifically, since the widespread use of micro-computers – your own PC (personal computer). The processing capabilities of computers have undoubtedly led to enormous technological advances and improvements in both the individual products and services we use every day and the processes used for their manufacture and provision. Think of how advanced computer technology features in products (eg the anti-theft immobilisers in vehicles) or in services (eg automatic teller machines [ATMs]) or manufacturing processes (robotic assembly) and provision (telecommunication for online processing). Technology, however, includes much more than the PC. Phenomenal technological improvements have undoubtedly occurred in products and services since the widespread introduction and integration of computer power into the manufacturing and service provisioning processes (we refer to this as the utilisation of process technology).

However, technology also includes machines, equipment and other devices used in the processes of transforming material, information and “customers/clients”. One can also refer to all types of indirect process technology or gadgets in the factory, or elsewhere (at home) that make life a little easier and promote productivity, communication, safety and general quality of life.

Finally, as pointed out in your prescribed book, the dominant force behind most technological advances in recent years has been the availability of low-cost microprocessing. Today there is hardly any relatively sophisticated product (ie a fridge, stove, TV, motor vehicle, automated gates, etc) or regularly used service operation (ie banking, paying accounts, medical and dental services, etc) that is not in some way based on a microprocessor.

5.3 MATERIALS, INFORMATION AND CUSTOMER/CLIENT PROCESSING TECHNOLOGIES



ACTIVITY 5.3

Read the following sections of chapter 8 entitled “Materials-processing technology”, “Information-processing technology”, “Customer-processing technology” and “Process technology should reflect volume and variety” in your prescribed book and then answer and/or complete the following:

- (1) Important issues of materials-processing technology include the way technologies are controlled (ie the use of computer numerically controlled [CNC] machine tools), which are with the following advantages and robotics, which are, are classified as follows in terms of their application,,, have the following advantages, the way materials are physically moved (that is, automated guided vehicles [AGV] which are, with the following advantages and the way the manufacturing systems are organised (that is, flexible manufacturing systems which are with the following advantages
- (2) What are the component parts of flexible manufacturing systems (FMS)? In what circumstances (or manufacturing conditions) would they seem to be most appropriate, and what are the possible advantages or benefits of using FMS?
- (3) How was the integration initiative of FMS given further stimulation by developments in computer-integrated manufacturing (CIM)? What does the third and final stage in the progressive integration of basic process technologies, namely computer-integrated enterprises (CIE) entail?
- (4) Provide a summary of the various materials-processing technologies (namely, CNC machine tools; industrial robots; AGVs; FMSs; CIM) in terms of the following key questions: (i) What does it do? (ii) How does it do it? (iii) What advantages does it give? (iv) What constraints does it impose?
- (5) Information processing technologies include (provide a description of what they entail in general) and the most common single type of technology within operations is computer-based technologies, which are often constrained by organisational and operational issues in as much that
- (6) What is the distinction between centralised and decentralised information processing and in what way did each contribute to the development of local area networks (LAN) and the ethernet?

- (7) What factor contributed most to the dramatic growth in the range of telecommunications and how does each of the following contribute to the further development of communications: (i) the internet, (ii) the world wide web (iii) extranets (iv) e-business (v) m-business?
- (8) In what way do management information systems (MISs) benefit businesses in general and how can decision-support systems (DSSs), expert systems (ESs) and automatic identification technologies contribute to business?
- (9) Provide a summary of the various information-processing technologies (ie LANs; internet; extranet; DSSs; ESs) in terms of the following key questions: (i) What does it do? (ii) How does it do it? (iii) What advantages does it give? (iv) What constraints does it impose?
- (10) Why is it argued that the use of customer/client processing technology in service operations is just as important as the use of materials-processing technology in manufacturing?
- (11) What is the difference between the two types of customer/client-processing technology in (i) active interaction technology, and (ii) passive interactive technology?
- (12) Technology involving customer/client interaction may be classified as
 - (i) passive interactive technology, meaning and my own three practical examples are
 - (ii) active interactive technology, meaning and my own three practical examples are
- (13) Hidden technology used in customer/client processing refers to and my own three examples of its use are
- (14) What does customer/client interaction with technology through an intermediary involve and why is it necessary, in many cases, to strictly regulate the use of such technologies?
- (15) Why is it necessary to train customers/clients in the use of technology in situations which require active interaction? What are the relevant limiting factors?
- (16) Provide a summary of the various customer/client-processing technologies (ie in-flight entertainment; moving walkways; bar code sensors; airline check-in) in terms of the following key questions: (i) What does it do? (ii) How does it do it? (iii) What advantages does it give? (iv) What constraints does it impose?
- (17) Why does technology reflect the volume-variety requirements of the operation? How does this relate to the scale and connectivity of the technology?



FEEDBACK: ACTIVITY 5.3

- (1) Questions 1 to 4. These deal with material-processing technologies. Note the case studies of "Automated systems reduce the risk in Banks" in chapter 8 of your prescribed book and answer the questions at the end of the case example. Also note the critical remarks made by the authors of your prescribed book in chapter 8 concerning the use and flexibility advantage of FMS.
- (2) Questions 5 to 9. These deal with information-processing technologies. Note the illustration of the dramatic growth in websites since 1991 (read the short case study on "Shoprite Checkers and Computicket" in your prescribed book) and the equally dramatic reduction in average transaction costs for bank technologies (fig 8.3 in your prescribed book). Also study table 8.4 in your prescribed book, which gives examples of applications of expert systems in POM.
- (3) Questions 10 to 16. These deal with customer/client-processing technologies. Read the short case study "QB House speeds up the cut". Make a clear distinction between active

interaction with technology and passive interaction with technology as well as the use of technology through an intermediary or hidden interaction.

- (4) *Question 17. Small scale process technologies will be more appropriate in high variety and low volume operations processes. Study figure 8.5 in your prescribed book and note the different process technologies that are associated with volume-variety combinations. It is clear that different process technologies will be appropriate for different parts of the volume-variety continuum. Scalability is influenced by the same volume-variety characteristic. Connectivity (or coupling) is generally more suited to relatively low variety and high volume.*
 - (5) *To summarise: after reviewing the study material for this activity, you will realise that, for all practical purposes, it is impossible to manufacture any product or provide any service without using, to a greater or lesser degree, materials, information and/or customer/client processing technologies.*
-

5.4 CHOICE OF PROCESS TECHNOLOGY



ACTIVITY 5.4

In order to make technology choices, it is useful to return to two of the perspectives we took on operations strategy: namely, market requirements perspective and the operations resource perspective. POM needs to manage process technology's contribution to operations effectiveness, which implies the decision between the different types of process technology. Read the last section of chapter 8 entitled "Choice of technology" in your prescribed book and then answer the questions and/or complete the following:

- (1) What do the market requirements evaluation and the operations resources evaluation perspectives regarding the choice of technology entail?
 - (2) What does the operations resources evaluation regarding the choice of technology entail? Briefly, how should a financial evaluation of investing in process technology be done?
-



FEEDBACK: ACTIVITY 5.4

- (1) *Questions 1 and 2. These questions deal with the technology choices in terms of the market requirements perspective and the operations resource perspective. Read the short case study "SVT programme investment in technology" in terms of the main criteria for choosing between alternative technology options in chapter 8 of your prescribed book and answer the question at the end of the case study. Also study the worked-out example of the costing and cost-savings exercise at the warehouse in chapter 8 of your prescribed book. Do you agree with the financial analysis?*
 - (2) *To summarise: it should be clear that the decision on whether to increase and/or improve the process technology used in the operation does not merely involve financial implications (ie the availability of funds, costs, budgets, etc). Other issues of concern to the operation, such as reduced variability, increased flexibility and greater vulnerability, may also dictate the extent to which technology will be utilised (ie the degree of automation, the scale of technology and the degree of integration).*
-



CHECK LIST

Now that you have completed study unit 5 on utilising process technology in operations, you should be able to do the following:

- Explain what process technology in operations entails.
- Describe which process technology developments are currently taking place in the operations of (a) materials processing; (b) information processing; and (c) customer/client processing.
- Use your knowledge of and insight into
 - process technology in operations
 - process technology developments which are currently taking place in the operations of
 - materials processing
 - information processing
 - customer/client processing

to explain how process technology reflects volume and variety.

- Explain the choice of technology in view of market requirements and the operations resource evaluation perspectives (including a financial evaluation).
- Justify their importance and demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.
- Demonstrate your appreciation for utilising process technology in operations by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



SUMMARY

This study unit examined the use of process technology in operations. In conjunction with the previous study unit, it dealt with the last aspect of design in operations covered in your prescribed book. The other aspects of design in operations previously examined in the second-year module on production and operations management, MNO2601, were as follows:

- the general nature of design in operations (MNO2601: study unit 7 but reviewed here in study unit 4)
- the stages of design with a view to gaining a competitive advantage: from concept to specification (MNO2601: study unit 8)
- the design of the production and operations network (MNO2601: study unit 9)
- design of layout and work flow (MNO2601: study unit 10)
- job design and work organisation (MNO2601: study unit 11).

The next four topics will all deal with a certain aspect of the planning and control of the production and operations management system.



ASSESSMENT

- (1) Study the case study entitled “Rochem Ltd” at the end of chapter 8 of your prescribed book and answer the questions at the end of the case study.
- (2) Complete study activities 1 to 4 at the end of chapter 8 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, others may even require that you visit your local business/organisation to investigate an aspect of the subject for yourself.

TOPIC 4

MATERIALS REQUIREMENTS PLANNING

AIM

To provide a review of the general nature of planning and control activities in operations and explain what enterprise resource planning is and why it is important for production/operations management.



LEARNING OUTCOMES

When you have worked through this study unit, you should be able to do the following:

- Explain what operation planning and control entail.
- Demonstrate how the nature of demand and supply could influence planning and control in operations.
- Describe what the tasks of planning and control in operations involve and give examples to illustrate how each task is applied in practice.
- Explain the volume-variety effect on the task of operation planning and control.
- Describe what enterprise resource planning (ERP) entails and how it developed.
- Explain what the information input requirements of MRP are and what the outputs derived from these will be.
- Show that you can do MRP calculations.
- Describe what manufacturing resource planning (MRP II) entails and explain how ERP develops, including web-integrated ERP, supply chain ERP and optimised production technology (OPT).
- Use the knowledge, insight and skills you have attained of
 - the general nature of planning and control of the operation
 - the nature of demand and supply and its effect on planning and control of the operation
 - the tasks of planning and control in operations
 - the volume-variety effect on the planning and control task of operations
 - enterprise resource planning (ERP)
 - the information input requirements of MRP and the outputs derived from these (7) MRP calculations
 - manufacturing resource planning (MRP II) and ERP including web-integrated ERP, supply chain ERP and optimised production technology (OPT)

to justify the importance of all eight and demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice format and essay-type questions.

- Show that you appreciate the need for capacity planning and control by explaining the theoretical concepts and demonstrating that you can apply the relevant production/operations skills in practice.
-

MATERIALS REQUIREMENTS PLANNING

Study unit 6	General nature of planning and control in operations: a review (chapter 10)
Study unit 7	Enterprise resource planning (chapter 14)

Study unit 6

GENERAL NATURE OF PLANNING AND CONTROL IN OPERATIONS: A REVIEW



KEY CONCEPTS

planning and controlling the operation	reconciling supply with demand
planning concerns the future	control copes with changes
balance of planning and control	volume-variety effect on planning and control
nature of supply and demand	dependent demand
uncertainty in supply and demand	resource-to-order
independent demand	make-to-stock
make-to-order	total throughput time
P:D ratios	loading
demand time	valuable operating time
finite/infinite loading	customer/client priority
sequencing	LIFO – last in first out
due date (DD)	longest operation/longest total job
FIFO – first in first out	time first (LOT)
shortest operation/shortest total job	Johnson's rule
time first (SOT)	complexity of scheduling
scheduling	Gantt charts
forward/backward scheduling	rostering
scheduling work patterns	push/pull control
monitoring and controlling the operation	drum, buffer, rope
theory of constraints	

GETTING AN OVERVIEW

In this study unit we will cover the first four learning outcomes of topic 4. We will look at operation planning and control, the nature of demand and supply and its effect on planning and control in operations, the tasks of planning and control in operations, and the volume-variety effect on the operation planning and control task.

6.1 INTRODUCTION IN THE PRESCRIBED BOOK



READ

To obtain a thorough orientation to this study unit, start reading the introduction to chapter 10 in your prescribed book and note the basic composition of figure 10.1. This figure depicts a model of the planning and control activities in production/operations

management. You need to memorise this figure because it serves as a mind map for the remainder of the study unit. After you have done this, read the points listed under the following questions: “What is planning and control?”, “What is the difference between planning and control?”, “How does the nature of demand affect planning and control?”, and “What is involved in planning and control?” in the summary answers to key questions at the end of chapter 10.

6.2 PLANNING AND CONTROL IN OPERATIONS



ACTIVITY 6.1

Read the case study entitled, “Joanne manages the schedule” in chapter 10 of your prescribed book and then answer the following questions:

- (1) What are the three types of work at the BMW dealership that need to be scheduled?
 - (2) How does the computer-based scheduling system at the BMW dealership help Joanne and her colleagues handle between 50 and 80 jobs every day?
-



FEEDBACK: ACTIVITY 6.1

- (1) Question 1. There are three types of work that need to be organised at the BMW dealership: (a) repair work on customers’ vehicles which normally has to be done as soon as possible; (b) routine servicing that is usually not so urgent (customers are willing to make bookings for these); and (c) pre-delivery service and extensive checks made on pre-owned cars which, again, are not urgent, but where, nevertheless, the buyer demands good service.
 - (2) Question 2. Note that all jobs are entered into the computer-based scheduling system which shows the total daily capacity. This includes all jobs that have been booked in, along with customers’ details. It is thus possible at any point in time to see whether any “surplus” capacity exists for adding jobs. While BMW does provide standard times for all major repair jobs, these need to be modified for local circumstances; however, the jobs and expected duration of these jobs can still be determined. The planning system can provide a print-out of all jobs which are to be undertaken every day and the parts that will probably be needed, stock list of parts, etcetera. However, note that, everyday, staff must cope with the unexpected – extra work may be required, customers may want something extra done, technicians become ill, parts may not be available, or customers may forget and just do not turn up. Joanne says that “we can cope with most of these uncertainties because our technicians are flexible in terms of the skills they have and are willing to work overtime when needed”.
-



ACTIVITY 6.2

Study the first section of chapter 10 in your prescribed book entitled “What is planning and control?” and then answer the questions and/or complete the following:

- (1) The purpose of planning and control in operations is
- (2) Which two “entities” in an operation do the planning and control activities reconcile?
- (3) Why do the authors of your prescribed book link operation planning and control, given that one can argue that, theoretically, these are separate concepts?

- (4) How would a decreasing inability to change plans when time is short influence the nature of planning and control in the long, medium and short term?
-



FEEDBACK: ACTIVITY 6.2

- (1) Question 1. Note that the purpose of planning and control is “to ensure that the operation’s processes run effectively and efficiently and produce products and services as required by customers”.
 - (2) Question 2. Planning and control activities provide the systems, procedures and decisions for bringing together the resources of the operation which have a general capability to supply customers/clients with products/services and a set of general and specific demands from actual and potential customers/clients for products/services. This is why planning and control is seen as the reconciling activity between supply and demand.
 - (3) Question 3. Planning is “a formalization of what is intended to happen at some time in the future”, although a plan does not guarantee that an event will actually happen. (It is thus rather “a statement of intention”.) Control is “the process of coping with changes” in variables such as what the customers want and when they want it, suppliers who are unable to deliver on time, machine breakdown, staff absenteeism, etc. Thus control “makes the adjustment which allows the operation to achieve the objectives that the plan has set, even when assumptions on which the plan was based do not hold true”.
 - (4) Question 4. Note that the nature of planning and control activities change over time. In long-term planning and control, operations managers make plans for what they intend to do, what resources they need, and what objectives they hope to achieve. The emphasis is thus on planning and not control. Medium-term planning and control is “concerned with planning in more detail (and replanning if necessary)” and “looks ahead to assess the overall demand which the operation must meet in a partially disaggregated manner”. In short-term planning and control, “many of the resources will have been set and it will be difficult to make large-scale changes” although “short-term interventions are possible if things are not going to plan” and “by this time, demand will be assessed on a totally disaggregated basis”. Study figure 10.2 in your prescribed book and note the balance between planning and control activities as the time horizon changes from hours/days to months/years.
 - (5) To summarise: note that the planning and control activities set the operation in motion. Both the effectiveness (making or delivering products or services as they are required by customers/clients) and efficiency (maximising output in relation to inputs) of the utilisation of resources required to meet the demands of actual and potential customers/clients for specific products/services are important.
-



ACTIVITY 6.3

Study the subsection “The volume-variety effect on planning and control” of chapter 10 in your prescribed book and answer the following question:

- (1) How could high/low volume and high/low variety operations influence customer/client responsiveness, the planning horizon, major planning decisions, control decisions and robustness?
-



FEEDBACK: ACTIVITY 6.3

- (1) Question 1. Note that operations which produce a high variety of products and services in relatively low volume will have different customers who require a different set of factors and use processes which have a different set of needs from those that create standardised products and services in high volume. Also study table 10. 1 and note the differences that the volume-variety effect has on the planning horizon, major planning decisions, control decisions and robustness.
-

6.3 NATURE OF DEMAND AND SUPPLY IN OPERATIONS



ACTIVITY 6.4

Study the second section of chapter 10 in your prescribed book entitled “Nature of demand and supply” and then answer the following questions:

- (1) Why could uncertainty in demand and supply influence planning and control activities?
 - (2) What is the difference between dependent and independent demand and how would each influence the planning and control activities of operations?
 - (3) What are the differences in the planning and control activities for “make-to-stock”, “make-to-order” and “resource-to-order” operations and how would their total throughput time (P) and demand time (D) differ?
-



FEEDBACK: ACTIVITY 6.4

- (1) Question 1. Some operations are reasonably predictable and run to plan, thus the need for control is minimal. In others, the supply and/or demand may be unpredictable owing to uncertainty in supply and/or demand. In this case, it is therefore necessary to replan quite often and increase control activities.
- (2) Question 2. Dependent demand is “relatively predictable because it is dependent upon some factor which is known”. In other words, dependent demand planning and control will concentrate on the consequences of the demand within the operation such as the MRP or materials requirements planning approach. On the other hand, independent demand operations will supply demand without having any firm idea of customers’ orders and thus run the risk of being out of stock when demand is greater than the operation can supply. This is the nature of independent demand planning and control where, through its inventory, the operation attempts to respond quickly by putting resources in place to satisfy demand. Also study figure 10.3 in your prescribed book for illustrations of dependent/independent demand operations.
- (3) Question 3. Note that the “dependent and independent demand concepts are closely related to how the operation chooses to respond to demand”. In other words, in conditions of independent demand, an operation will only start the process of producing goods or services when a firm customer order is confirmed (resource-to-order). In conditions where the operation is more confident of the nature of demand, but still does not know its volume or timing, it may still only make the actual product or service once a firm order is placed, but will keep the resources in stock to satisfy demand quickly (make-to-order). In conditions of dependent demand, operations will produce goods ahead of orders and keep them in stock (make-to-stock). Determining the P:D ratios (P for “total throughput time” and D for “demand time”) for various operations is another way of characterising the relationship between the time when a customer/client “asks” for a product/service

and the time it takes the operation to obtain the resources, produce and/or deliver the product/service. High P:D ratios generally mean that the operations need a long time before they can respond to customers/clients needs and that these operations have a higher degree of uncertainty in their planning and control activities because of the longer time span involved in "order-by-customer/client-to-production/delivery-by-operation". Nevertheless, it should be noted that because demand (D) itself is usually only a prediction, subject to considerable uncertainty, no matter how much greater P is than D, the risk of inaccurate operations planning and control decisions is greater. Reducing the P:D ratios thus becomes a way of taking some risk out of planning and control. Study figure 10.4 ("make-to-stock", "make-to-order" and "resource-to-order" operations) in your prescribed book.

6.4 PLANNING AND CONTROL ACTIVITIES



ACTIVITY 6.5

Study the third section of chapter 10 in your prescribed book, entitled "Planning and control activities" and then answer the questions and/or complete the following:

- (1) Planning and control require the reconciliation of supply and demand in terms of
 - (a) loading, which means determining the
 - (b) sequencing, which means determining the
 - (c) scheduling, which means deciding on
- (2) When loading a work centre, why is there normally a difference between the maximum time available and the actual running time?
- (3) What is the difference between finite and infinite loading and in which types of operations is each relevant?
- (4) How would the priorities given to work be influenced by using each of the following sequencing rules: customer/client priority, due dates, LIFO; FIFO, longest operation/longest total job time first, and shortest operation/shortest total job time first?
- (5) What is a Gantt chart and how can it be used to track progress in jobs and work centres?
- (6) Why is scheduling said to be one of the most complex tasks in production/operations management? How many possible schedules could an operation have if it had three different jobs to do and two machines that operated independently of each other?
- (7) What is the difference between forward and backward scheduling and which approach complements just-in-time (JIT) operations? Where is rostering used and why is scheduling staff times considered even more complex?
- (8) What does the monitoring and control activity regarding the volume and timing reconciliation between supply and demand involve and how can push and pull control influence inventory build-up in operations?



FEEDBACK: ACTIVITY 6.5

- (1) Question 1. Note that planning and control requires reconciliation of supply and demand in terms of volumes, timing and quality. To reconcile volume and timing (quality is discussed later in this module) four overlapping activities are performed: loading (the amount of work that is allocated to a work centre); sequencing (the order in which the work will be performed); scheduling (the detailed timetable showing at what time or date jobs should start and when they should end); and monitoring and control. Given

the plan of the operation through loading, sequencing and scheduling, each part of the operation needs to be monitored to ensure that planned activities are indeed happening. Also study figure 10.5 in your prescribed book for an illustration of the planning and control activities and what each attempts to achieve.

- (2) *Question 2. The difference between maximum available time and the valuable operating time of, for instance, a machine, takes into consideration certain “losses in time” which are unavoidable (public holidays, weekends, equipment idling, set-up and changeover, not working [planned], etc) and avoidable (ie quality losses, slow running equipment, breakdown failure, not working [unplanned], etc) in well-run operations. Also study figure 10.6 in your prescribed book.*
- (3) *Question 3. Finite loading is “an approach which only allocates work to a work centre up to a set limit”, which is the estimate of the capacity of the work centre, while infinite loading is “an approach to loading work which does not limit the acceptance of work, but tries to cope with it”. Study figure 10.7 for illustrations of both finite and infinite loading and note where each approach is particularly relevant to an operation.*
- (4) *Question 4. Note that, when priorities are given to work in an operation, some predefined set of rules may apply or, alternatively, physical constraints (physical nature of materials being processed) may determine the priority. Some of these predefined set of sequencing rules include the following: customer/client priority sequencing (important or aggrieved customers/clients are processed prior to others, irrespective of the order of arrival); due date (DD) (work sequenced according to when the order is due for delivery, irrespective of the size of each job or importance of the customer/client); last in first out (LIFO) (selected for practical reasons meaning those last in, move out first); first in first out (FIFO) (customers/clients are served as they arrive, this is also known as first come first serve); longest operation time first (LOT) (jobs that take the longest go first; and shortest operation time first (SOT) (when cash constrained operations may do the short jobs first to invoice, get payment quicker and improve cash flow). Read the case study of “Triage at Chris Hani Baragwanath Hospital” in chapter 10 of your prescribed book and answer the questions at the end of the case study. Also study the worked-out example of “Zimasa Koyana, the website designer” in chapter 10 of your prescribed book. Do you agree with his calculations of FIFO, DD, and SOT? Compare your calculations with those in table 10.2 of your prescribed book. Finally, note that the five performance objectives may also be used to judge the effectiveness of the sequencing rules – for example, dependability (meeting due dates promised), speed (minimising the time a job spends in process) and cost (minimising work-in-process inventory and minimising idle time of work centres).*
- (5) *Question 5. Gantt charts are used as a method of scheduling. A Gantt chart is a simple tool which represents time as a bar channel on a chart. Study figure 10.10 (which illustrates a Gantt chart).*
- (6) *Question 6. Note that schedules reflect a statement of volume of work to be done and time allocated to operations; the purpose of schedules is to ensure that customer demand is met. In rapid-response service operations, where customers arrive in an unplanned manner, schedules will obviously not work and the operation can only respond to demands as they occur. However, note that the scheduling activity is considered one of the most complex tasks in production/operations management, because it must deal with several different types of resources simultaneously (ie machines have different capabilities and capacities) and the number of possible schedules increase rapidly as the number of activities and processes increase. For example, with one machine and five different jobs, there are 120 possible different schedules or generally for [n] jobs there are [n!] different ways of scheduling the jobs through a single process. For more than one machine, the possible number of schedules is $(n!)^m$. Thus for three different jobs and two machines we could have $3 \times 6 \times 2 \times 6 \times 1 = 6 \times 6 \times 6 = 36$ possible schedules. Finally, read the case study “The life and times of a chicken salad sandwich – part one” in chapter 10 of your prescribed book and answer the questions at the end of the case study.*

- (7) Question 7. Forward scheduling involves starting work as soon as it arrives, while backward scheduling involves starting the jobs at the last possible moment (to prevent them from being late). Also study table 10.3 in your prescribed book and note the advantages of forward backward scheduling. In theory, both MRP (material requirements planning) and JIT (just-in-time) use backward scheduling – in other words, only starting work when it is required. Scheduling work patterns refers to a situation where the dominant resource in the operation is its staff and the schedule of work times effectively determines the capacity of the operation itself. The main task here is therefore to make sure that a sufficient number of people are working at any point in time to provide the capacity appropriate to the level of demand. Note some of the issues involved in scheduling staff times as described by the authors of your prescribed book in chapter 10 (ie capacity must match demand, the length of each shift must not be too long or short, working unsociable hours to be minimised, days off must match staff conditions of employment, vacation and other times off, sufficient flexibility maintained to cover unexpected changes in staff due to sickness and demand surges, etc). All of these obviously increase the complexity of this type of scheduling.
- (8) Question 8. Note that, after a plan has been created for the operation through loading, sequencing and scheduling, each part of the operation has to be monitored to ensure that planned activities indeed happen. Any deviation from the plans must be rectified through some kind of intervention and may involve replanning. Also study figure 10.14 in your prescribed book for an illustration of a simple control model. A key distinction between intervention signals is those that push work through the process within the operation and those that pull work only when it is required. In the case of “push”, work is pushed out without considering whether the call centre can handle it (or idle time may occur), or there is inventory build-up or queue-forming. In the case of “pull”, the customer works as trigger to pull the work from the preceding work station. Note that in pull systems there is less likely to be inventory build-up and this approach is therefore favoured in JIT operations. Also study figure 10.15, which illustrates a push-and-pull control system operation, and note the inventory build-up in such system. Deciding exactly where in the process control should be, Goldratt (inventor of the concepts Theory of Constraints [ToC] and Optimized Production Technology [OPT]) argued that the point of control should be the bottleneck. This is called the “drum”, because it sets the beat for the rest of the process to follow and because, by definition, it does not have enough capacity and therefore should be working all the time. It is therefore sensible to set up a buffer of inventory in front of the bottleneck to make sure it always has something to work on. It is not worthwhile the parts in the process before the bottleneck working to their full capacity, since this will only lead to inventory build-up. Some form of communication (called the rope) between the bottleneck and the input to the process is therefore needed to make sure that activities before the bottleneck do not overproduce. Study figure 10.16 in your prescribed book where the concepts of “drum/bottleneck”, “buffer” and “rope” are illustrated. Also study the critical remarks made by the authors of your prescribed book in chapter 10 regarding how “easy or difficult” it is to control an operation. We agree with the authors here. Note the set of useful questions for assessing the difficulty associated with control of any operation as illustrated in figure 10.17 in your prescribed book (namely, consensus over the operation’s objectives, measurability of the operation’s outputs, knowledge of the operation’s behaviour, degree of repetition of the operation’s activities).
- (9) To summarise: note that scheduling is the most complex planning and control task in operations. Not only may there be, theoretically, several possible schedules for any given situation (as many as 12 in the case of three jobs being served by two independent machines), but the practical or real situation adds to the complexity by including various possible routings, as do market variations and product mix changes.



CHECK LIST

Now that you have completed study unit 6, which reviewed the general nature of planning and control in operations you should be able to do the following:

- (1) Explain what the planning and control of operations entails.
- (2) Demonstrate how the nature of demand and supply could influence operation planning and control.
- (3) Describe the activities involved in operation planning and control and give examples of how each activity is applied in practice.
- (4) Explain the volume-variety effect on the operations planning and control.
- (5) Use the knowledge, insight and skills you have gained into
 - the general nature of planning and control of the operation
 - the nature of demand and supply and its effect on planning and controlling the operation
 - the tasks of planning and control in operations
 - the volume-variety effect on the planning and control task of operations

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice format and essay-type questions.

- (6) Show that you appreciate the need for planning and control in operations by explaining the theoretical concepts and demonstrating that you can apply the relevant production/operations skills in practice.



SUMMARY

This study unit examined the general aspects of planning and control in the production/operations management system while the next, study unit 7, will focus specifically on enterprise resource planning.



ASSESSMENT

- (1) Read the case study entitled “Air traffic control: a world-class juggling act” at the end of chapter 10 in your prescribed book and then answer the question.
- (2) Complete study activities 1 to 3 at the end of chapter 10 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, others may even require that you visit your local business/organisation to investigate an aspect of the subject matter yourself!

Study unit 7

ENTERPRISE RESOURCE PLANNING



KEY CONCEPTS

enterprise resource planning (ERP)	material requirements planning (MRP)
bill of materials (BOM)	master production schedule (MPS)
manufacturing resource planning (MRP II)	web-integrated ERP
demand management	customers/clients orders
forecast demand	inputs to the MPS
available to promise (ATP)	chase MPS
level MPS	levels of assembly
component structure	single-level bills of materials
indented bills of materials	inventory records
item master file	transaction file
location file	MRP netting process
back scheduling	MRP capacity checks
supply chain ERP	optimised production technology (OPT)
theory of constraints (TOC)	"A"-shape product structure
product structure shapes	"V"-shape product structure
"T"-shape product structure	resource requirements plans (RRP)
"X"-shape product structure	capacity requirements plans (CRPs)
rough-cut capacity plans (RCCPs)	

GETTING AN OVERVIEW

In this study unit we will address the last four learning outcomes of topic 4. We will look at: (i) the concept of enterprise resource planning (ERP); (ii) how ERP develops; (iii) MPS and MRP calculations; (iv) manufacturing resource planning (MRP II) and ERP including web-integrated ERP, supply chain ERP and optimised production technology (OPT) and where it can be used.

7.1 INTRODUCTION IN THE PRESCRIBED BOOK



READ

It is important to first read the introduction to chapter 14 in your prescribed book and note the basic composition of figure 14.1. This depicts a model of the enterprise resource planning and control activities in production/operations management in terms of what the market requires and what the operation supplies. You need to memorise this figure because it serves as a mind map for the remainder of the study unit. After you have done this, read the points listed under the questions: "What is ERP?", "How did ERP develop?",

“What is MRP?”, “What is MRP II?” and the points listed under the question “How is ERP developing?” in the summary answers to key questions at the end of chapter 14.

7.2 THE CONCEPT OF ENTERPRISE RESOURCE PLANNING



ACTIVITY 7.1

Read the case study entitled, “SAP in Financial Services” in chapter 14 of your prescribed book.



ACTIVITY 7.2

Study the first section of chapter 14 in your prescribed book entitled “What is ERP?” and then answer the questions and/or complete the following:

- (1) ERP stands for and is the most recent development from the original which, as a system, helped calculate and the when they are required.
 - (2) What is the essence of ERP and how did it develop?
-



FEEDBACK: ACTIVITY 7.2

- (1) Question 1. ERP stands for Enterprise Resource Planning and is the most recent development from the original material requirements planning (MRP) which, as a system, helped calculate the quantity and types of materials required (or volume calculations) and the times (or the timing calculations) they are required.
- (2) Question 2. To “make sure that the right materials in the right quantities arrive at the right place at the right time” requires “planning and control, not only of materials but also finance, purchasing, people, equipment and many other activities”. ERP helps organisations to “plan forward” for these types of decisions and understand the implications of any changes to the plan. It thus integrates information from all parts of the organisation, as illustrated in figure 14.3 of your prescribed book. Its development, as we pointed out above, is from the original material requirements planning (MRP) philosophy which, owing to computer processing capability, could drive the basic planning and control mathematics of the volume and timing calculations for manufacturing in a fast, efficient and flexible way. After that, manufacturing resource planning (MRP II) expanded the capabilities of MRP by allowing for LAN (Local Area Network) communication between different parts of the organisation and forward modelling of “what-if” scenarios. The strength of both MRP and MRP II lay in their ability to quickly and accurately view the consequences of changes to what an operation was required to do (ie if demand changed, the MRP systems could calculate all the “knock-on” effects and issue change instructions). With ERP systems, the same principle applies but on a much wider scale, because all parts of the organisation are integrated on the same databases, so the consequences of any decisions influencing the planning and control in one part of the organisation, will be reflected throughout the rest or other parts of the organisation. A further development with ERP is made possible through web-based communication where other parts of the business, suppliers and customers/clients geographically located elsewhere (nationally

or internationally) with similar ERP capabilities, can tie in and communicate with one another. This degree of integration, which could include technical, organisational and strategic concerns, will be made possible with web-integrated ERP systems (also known as “collaborative commerce”).

7.3 MATERIALS REQUIREMENTS PLANNING (MRP) INFORMATION



ACTIVITY 7.3

In order to do MRP several sources of information is needed. The same applies to the several inputs to the MPS that enable the MPS to drive MRP. Study the second section of chapter 14 in your prescribed book entitled “Material requirements planning (MRP)” and then answer the questions and/or complete the following:

- (1) The inputs to MRP are the
 - (a) master production schedule (MPS), which provides information on which has its inputs customer/client orders which provide information on and the demand forecast which provides information on
 - (b) bills of materials which provides information on
 - (c) inventory records which provide information on
 - (2) The outputs of MRP are
 - (a) purchase orders which show
 - (b) materials plans which show
 - (c) works orders which show
 - (3) What does the term “demand management” include?
 - (4) How are orders and forecasts combined to represent demand and what is the significance of forecasting for different types of operations?
 - (5) What are the inputs to the master production schedule and how would a chase and level MPS impact on the number of finished items of simple practical examples that need to be completed (or produced), in terms of how much is available (inventory) and how much is available to promise (ATP) in the weeks ahead?
 - (6) How is the product structure broken down into various levels of assembly and what are the distinguishing features of A-shape, T-shape, V-shape and X-shape product structures?
 - (7) What is the difference between single-level and indented bills of materials and how, in practice, would they differ in appearance?
 - (8) How is inventory managed in MRP systems and why is it so important that inventory files are accurate?
-



FEEDBACK: ACTIVITY 7.3

- (1) Question 1. The inputs to MRP are (see also figure 14.5 in your prescribed book):
 - (a) the master production schedule (MPS) which provides information on demand which has its inputs customer/client orders which provide information on firm

- orders scheduled and the demand forecast which provides information on realistic estimates of the quantity and timing of future orders.*
- (b) the bills of materials which provides information on the product structure (level, part number, description and quantity).*
 - (c) the inventory records which provide information on the parts or items that are already in stock in the form of finished goods, work-in-progress or raw materials, components, parts, etc.*
- (2) Question 2. The outputs of MRP are (also see figure 14.4 in your prescribed book):*
- (a) purchase orders which show the quantity and time required for the net requirements of items, raw materials, components, parts, etc which are bought from suppliers.*
 - (b) materials plans which show the material requirements at each level and part or component of the bill of materials for each product.*
 - (c) works orders which show the net requirements for items, components, parts, etc which are made in-house.*
- (3) Question 3. Demand management combines the management of customer orders and sales forecast which feeds into the MPS and includes the set of processes which interface with the customer and the market.*
- (4) Question 4. Confirmed customer orders reflect the records of exactly what each customer has ordered, how many they have ordered and when they require delivery (known orders). (Note that the details of these sales orders may change several times after they have been placed.) The forecast of demand tries to predict ahead what the likely orders (forecasted orders) will be and the combination of the two is used to represent demand for the organisation. The mix of known orders and forecasted orders will also be different for different types of operations. In a make-to-order business, the visibility of known orders over time will be greater than for the make-for-stock business while, for the purchase-to-order business, most raw materials will only be ordered once confirmed customer orders are received. In a resource-to-order business, raw materials will not be ordered, and contracts for labour and equipment will not be placed.*

ANNEXURE 1

THE MASTER PRODUCTION SCHEDULE

The master production schedule (MPS) indicates the **quantity** and **timing** of **planned production**. This planned production will take into account the **quantity** and **timing** of desired delivery. It will also take into consideration on-hand inventory.

Against this backdrop, we acquire an understanding of the **three inputs** to the MPS, namely:

- Input 1: The beginning inventory
- Input 2: Forecasts for each period
- Input 3: Customer orders (quantities already committed to customers)

As far as **outputs** are concerned, the master scheduling process uses this information on a period-by-period basis to determine:

- Output 1: Projected inventory
- Output 2: Production requirements
- Output 3: Resulting uncommitted inventory. This is referred to as available-to-promise (ATP) inventory.

Production requirements (Output 2) for an MPS will differ according to the **MPS strategy** adopted by the relevant company/ master production scheduler.

MPS strategies:

Typically, an MPS schedule will follow either a chase production schedule or a level production schedule

- **Chase production schedule**

Chase production scheduling involves the MPS increasing as demand increases and aims to keep available inventory low.

- **Level production schedule**

Level production scheduling involves averaging the amount required to be completed to smooth out peaks and troughs; it generates more inventory than chase production scheduling.

The best means of explaining how to complete an MPS schedule is to carry out an example and explain the actions step by step.

Details will be provided of a master production scheduling scenario. The details will include information relating to the three inputs (referred to above within this tutorial). You will be required to derive information relating to the three outputs (referred to above within this tutorial).

We will be carrying out the same example three times. The reason for this is that you will be expected each time to adopt a different MPS strategy. The first **two** attempts fall under the category of a **chase production schedule**. The **third** attempt falls under the category of a **level production schedule**.

MPS PROBLEM 1:

Assume you are required to complete the MPS time-phase record for production of tables as an end item. The schedule below outlines the three inputs including the relevant data, as well as the **three outputs**. The three outputs do not yet contain

any data. This data will be calculated on the basis of the inputs as we go through the example:

		June				July			
		1	2	3	4	5	6	7	8
Input 2	Forecast	30	30	30	30	40	40	40	40
Input 3	Customer Orders	33	4	10	4	2			
Output 1	Projected on-hand inventory								
Output 2	MPS (planned production)								
Output 3	Available-to-promise Inventory (uncommitted)								
Input 1	On hand inventory: 64								

Further to these three inputs, you will need information relating to

- The safety stock size: Stocks in excess of average demand to cater for variability in demand and lead time.
- **The MPS strategy**

The **quantity** and **timing** of production (Output 2) will differ according to the MPS strategy adopted. The example above will be carried out three times according to three different MPS strategies:

- Chase Demand – with Fixed Batch Quantities (Example 1.1)
- Chase Demand – without Fixed Batch Quantities (Example 1.2)
- Level Demand – with Fixed Batch Quantities (Example 1.3)

The **fixed batch quantity** is the number of items produced in a batch each time production is called for.

NB: Another term for 'fixed batch quantities' is 'production lot sizes'. These terms are used interchangeably so make sure you are familiar with both!

Safety stock size and production (quantities and timing) are interconnected: Safety stock must never fall below a minimum level. This minimum level will differ between organizations. As stock approaches the minimum level, production is called for (in line with the MPS strategy), so as to avoid safety stock running below the minimum level.

The safety for all three scenarios will be 5 units.

EXAMPLE 1.1: CHASE DEMAND – WITH FIXED BATCH QUANTITIES

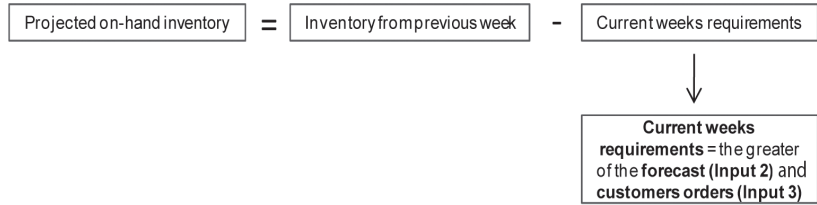
You are required to compile an MPS schedule for 'MPS Problem 1' using a chase demand strategy with fixed batch quantities of 70.

MPS schedules should be carried out in two separate steps:

- Step 1: Completion of Output 1 (Projected on-hand inventory) and Output 2 (Planned production)
- Step 2: Completion of Output 3 (Available-to-promise Inventory)

STEP 1: COMPLETION OF OUTPUT 1 (PROJECTED ON-HAND INVENTORY) AND OUTPUT 2 (PLANNED PRODUCTION)

First, we need to calculate the projected on-hand inventory, one week at a time, until it falls below the safety stock level. The projected on-hand inventory is calculated as follows



	June				July			
	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer Orders	33	4	10	4	2			
Projected on-hand inventory	31	71	41	11	41	71	31	61
MPS (planned production)		70			70	70		70
Available-to-promise (uncommitted)	▲	▲	▲	▲				
On-hand inventory: 64								
Production Lot size = 70								
Safety stock = 5								

Output 1 →

Output 2 →

64 (starting on-hand Inventory) – 33 (customer orders in period 1) = 31 (on-hand inventory at end of period 1). We always begin with the starting on-hand inventory. In period 1 there is a forecast of 30 and customer orders of 33. We need to subtract the larger of the two, namely the 33 customer orders, from the starting on-hand inventory of 64 to get to the projected-on-hand inventory of 31 at the end of period 1.

The projected on-hand inventory at the end of period 2 is 71. The thought process to get to this figure is as follows: The on hand inventory at the end of period 1 is 31. We then need to subtract the greater of the forecast and customer orders of period 2, to get to the projected on-hand inventory at the end of period 2. This sum would be as follows: 31 – 30 = 1.

The problem with this projected on-hand inventory of 1 is that it is below the safety stock level of 5. To avoid this, we require production, according to the lot-size, of 70 units. The projected on-hand inventory for the end of period 2 now changes as follows: 31 (projected inventory on-hand at end of period 1) – 30 (forecast for period 2) plus 70 (production lot size required in period 2) = 71 (projected inventory on-hand at end of period 2).

71 (on-hand inventory at end of period 2) – 30 (forecast in period 3) = 41 (on-hand inventory at end of period 3). We do not require production for this period, as projected on-hand inventory of 41 at the end of period 3 is greater than the safety stock level of 5

41 (on-hand inventory at end of period 3) – 30 (forecast in period 4) = 11 (on-hand inventory at end of period 4). We do not require production for this period, as projected on-hand inventory of 11 at the end of period 4 is greater than the safety stock level of 5

	June				July			
	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer Orders	33	4	10	4	2			
Output 1 → Projected on-hand inventory	31	71	41	11	41	71	31	61
Output 2 → MPS (planned production)		70			70	70		70
Available-to-promise (uncommitted)					▲	▲	▲	▲
On-hand inventory: 64								
Production Lot size = 70								
Safety stock = 5								

11 (on-hand inventory at end of period 4) – 40 (forecast in period 5) = -29 (on-hand inventory at end of period 5). We therefore require production of 70 units for this period.

The projected on-hand inventory for the end of period 5 now changes as follows: 11 (on-hand inventory at end of period 4) – 40 (forecast for period 5) plus 70 (production lot size required in period 5) = 41 (projected inventory on-hand at end of period 5).

41 (on-hand inventory at end of period 5) – 40 (forecast in period 6) = 1 (on-hand inventory at end of period 6). Since this is below the safety stock level of 5, we require production of 70 units for this period.

The projected on-hand inventory for the end of period 6 now changes as follows: 41 (on-hand inventory at end of period 5) – 40 (forecast for period 6) plus 70 (production lot size required in period 6) = 71 (projected inventory on-hand at end of period 6).

71 (on-hand inventory at end of period 6) – 40 (forecast in period 7) = 31 (on-hand inventory at end of period 7). We do not require production for this period, as projected on-hand inventory of 31 at the end of period 7 is greater than the safety stock level of 5.

31 (on-hand inventory at end of period 7) – 40 (forecast in period 8) = -9 (on-hand inventory at end of period 8). We therefore require production of 70 units for this period.

The projected on-hand inventory for the end of period 8 now changes as follows: 31 (on-hand inventory at end of period 7) – 40 (forecast for period 8) plus 70 (production lot size required in period 8) = 61 (projected inventory on-hand at end of period 8).

STEP 2: COMPLETION OF OUTPUT 3 (AVAILABLE TO PROMISE INVENTORY)

Now that we have completed output 1 (projected on-hand inventory) and output 2 (planned production), it is possible to determine output 3 (inventory that is available-to-promise, and hence uncommitted)

Available-to-promise (ATP) inventory is that portion of a firm's inventory and planned production that is not already committed and is available to the customer. This allows delivery promises to be made and customer orders and deliveries to be scheduled accurately.

Several methods are used in practice. The one we shall employ involves a 'look-ahead' procedure. This method assumes that the ATP will be sold before the next scheduled receipt arrives. In the 'look-ahead' procedure, The ATP quantity is only calculated for the **first week** and for other weeks in which there is an MPS quantity.

- **First week calculations**

In the first week, it is required that you sum customer orders of all weeks **up until, but excluding** the customer orders in the week in which there is a MPS quantity. This quantity is then subtracted from the on-hand inventory at the beginning to give you your ATP amount in week 1

- **Other weeks in which there is an MPS quantity**

In the weeks in which there is an MPS quantity, it is required that you sum the customer orders of **that particular week** and all the weeks thereafter **up until, but excluding** the customer orders in the week in which there is a MPS quantity. This quantity is then subtracted from the MPS (planned production quantity in that particular week)

Against the backdrop of this thought process, let us work through the calculations of the ATP in example 1.1:

	June				July			
	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer Orders	33	4	10	4	2			
Projected on-hand inventory	31	71	41	11	41	71	31	61
MPS (planned production)		70			70	70		70
Output 3 Available-to-promise Inventory (uncommitted)	31	52			68	70		70
On-hand inventory: 64	▲	▲			▲	▲		▲
Production Lot size = 70								
Safety stock = 5								

The customer orders in week 1 are 33. We will NOT sum the customer orders in week 2 because there is a MPS quantity in week 2.

We then subtract 33 from the on-hand inventory of 64 to get to the ATP quantity of 31.

The customer orders in week 2 are 4. In week 3, they are 10, and in week 4, they are 4. We therefore sum the customer orders of week 2, 3 and 4 to get to the total customer orders of 18. We do not consider the customer orders in week 5, because there is an MPS quantity in week 5.

We then subtract 18 from the MPS quantity of 70 in week 2 to get the ATP of 52.

The customer orders in week 5 are 2. We do not consider the customer orders in week 6, because there is an MPS quantity in week 6.

We then subtract the 2 customer orders from the MPS quantity of 70 in week 5 to get the ATP in week 5 of 68.

The customer orders in week 6 are 0 and in week 7 they are also 0. Total customers orders in week 6 and 7 are therefore 0. We do not consider the customer orders in week 8, because there is an MPS quantity in week 8.

We then subtract 0 from the MPS quantity of 70 in week 6 to get the ATP in week 6 of 70.

The customer orders in week 8 are 0 and there is no further info with regards to customer orders.

We therefore subtract 0 from the MPS quantity of 70 in week 8 to get the ATP in week 8 of 70.

EXAMPLE 1.2: CHASE DEMAND – WITHOUT FIXED BATCH QUANTITIES

You are required to compile an MPS schedule for 'MPS Problem 1' using a chase demand strategy whereby production should match demand, with a safety stock level of 5 units.

The difference in Example 1.2, is that production will not be carried-out in fixed quantities. We will produce only what we are required to produce, according to demand. We are also required to ensure that we never allow our stock to drop below the safety stock level of 5 units.

Once again, the MPS schedule should be done in two separate steps:

- Step 1: Completion of Output 1 (projected on-hand inventory) and Output 2 (planned production)
- Step 2: Completion of Output 3 (ATP Inventory)

STEP 1: COMPLETION OF OUTPUT 1 (PROJECTED ON-HAND INVENTORY) AND OUTPUT 2 (PLANNED PRODUCTION)

		June				July			
		1	2	3	4	5	6	7	8
	Forecast	30	30	30	30	40	40	40	40
	Customer Orders	33	4	10	4	2			
Output 1	Projected on-hand inventory	31	5	5	5	5	5	5	5
Output 2	MPS (planned production)		4	30	30	40	40	40	40
Available-to-promise (uncommitted)									
On hand inventory: 64									
Production lot size : N/A									
Safety stock = 5									

64 (starting on-hand inventory) – 33 (customer orders in period 1) = 31 (on-hand inventory at end of period 1). We always begin with the starting on-hand inventory. In period 1 there is a forecast of 30 and customer orders of 33. We need to subtract the larger of the two, namely the 33 customer orders, from the starting on-hand inventory of 64 to get to the projected-on-hand inventory of 31 at the end of period 1.

The projected on-hand inventory at the end of period 2 is 5. The thought process to get to this figure is as follows: The on-hand inventory at the end of period 1 is 31. We then need to subtract the greater of the forecast and customer orders of period 2, to get to the projected on-hand inventory at the end of period 2. This sum would be as follows: $31 - 30 = 1$.

The problem with this projected on-hand inventory of 1 is that it is below the safety stock level of 5. To avoid this, we require sufficient production, to match demand KEEPING A SAFETY STOCK LEVEL OF 5 UNITS. With our 1 unit of inventory falling below the safety stock level of 5 units, we would therefore require production of 4 units in period 2 to end up with a safety stock level of 5 units.

The calculations is as follows: 31 (projected inventory on-hand at end of period 1) – 30 (forecast for period 2) = 1 in lot size required in period 2) = 71 (projected inventory on-hand at end of period 2).

5 (on hand inventory at end of period 2) – 30 (forecast in period 3) = -25 (Inventory short at end of period 3). We therefore require production of 30 units to satisfy demand and keep the required safety stock level of 5 units.

	June				July			
	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer Orders	33	4	10	4	2			
Output 1 → Projected on-hand inventory	31	5	5	5	5	5	5	5
Output 2 → MPS (planned production)		4	30	30	40	40	40	40
Available-to-promise (uncommitted)				▲	▲	▲	▲	▲
On-hand inventory: 64								
Production lot size: N/A								
Safety stock = 5								

5 (on hand inventory at end of period 3) – 30 (forecast in period 4) = -25 (Inventory short at end of period 4).
We therefore require production of 30 units to satisfy demand and keep the required safety stock level of 5

5 (on hand inventory at end of period 4) – 40 (forecast in period 5) = -35 (Inventory short at end of period 5).
We therefore require production of 40 units to satisfy demand and keep the required safety stock level of 5

5 (on hand inventory at end of period 5) – 40 (forecast in period 6) = -35 (Inventory short at end of period 6).
We therefore require production of 40 units to satisfy demand and keep the required safety stock level of 5

5 (on hand inventory at end of period 6) – 40 (forecast in period 7) = -35 (Inventory short at end of period 7).
We therefore require production of 40 units to satisfy demand and keep the required safety stock level of 5

5 (on hand inventory at end of period 7) – 40 (forecast in period 8) = -35 (Inventory short at end of period 8).
We therefore require production of 40 units to satisfy demand and keep the required safety stock level of 5

STEP 2: COMPLETION OF OUTPUT 3 (AVAILABLE TO PROMISE INVENTORY)

	June				July			
	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer Orders	33	4	10	4	2			
Projected on-hand inventory	31	5	5	5	5	5	5	5
MPS (planned production)		4	30	30	40	40	40	40
Output 3 → Available-to-promise Inventory (uncommitted)	31	0	20	26	38	40	40	40
On-hand inventory: 64								
Production Lot size = N/A								
Safety stock = 5								

The customer orders in week 1 are 33. We will NOT sum the customer orders in week 2 because there is an MPS quantity in week 2.

We then subtract 33 from the on-hand inventory of 64 to get to the ATP quantity of 31.

The customer orders in week 2 are 4. We do not consider the customer orders in week 3, because there is an MPS quantity in week 3.

We then subtract 4 (the customer orders in week 2) from the MPS quantity of 4 in week 2 to get the ATP of 0.

The customer orders in week 3 are 10. We do not consider the customer orders in week 4, because there is an MPS quantity in week 4.

We then subtract 10 (the customer orders in week 3) from the MPS quantity of 30 in week 3 to get the ATP of 20.

The customer orders in week 4 are 4. We do not consider the customer orders in week 5, because there is an MPS quantity in week 5.

We then subtract 4 (the customer orders in week 4) from the MPS quantity of 30 in week 4 to get the ATP of 26.

The customer orders in week 5 are 2. We do not consider the customer orders in week 6 (even if there were), because there is an MPS quantity in week 6.

We then subtract 2 (the customer orders in week 5) from the MPS quantity of 40 in week 5 to get to the ATP of 38.

There are no customer orders in week 6, 7 and 8, but since there are MPS quantities in each of these weeks, we need to calculate the ATP. The ATP equals the MPS quantities because of the fact that there are no customer orders for these weeks.

EXAMPLE 1.3: LEVEL DEMAND – WITH FIXED BATCH QUANTITIES

You are required to compile an MPS schedule for 'MPS Problem 1' using a level demand strategy with fixed batch quantities of 30, with a safety stock level of 5 units.

In Example 1.3, production will be carried in fixed quantities of 30 units. We will produce 30 units within each period, regardless of demand. The Lot size of 30 is sufficient to ensure that the safety stock does not drop below the minimum level of 5 units.

Once again, the MPS schedule should be done into two separate steps:

- Step 1: Completion of Output 1 (projected on-hand inventory) and Output 2 (planned production)
- Step 2: Completion of Output 3 (ATP Inventory)

STEP 1: COMPLETION OF OUTPUT 1 (PROJECTED ON-HAND INVENTORY) AND OUTPUT 2 (PLANNED PRODUCTION)

	June				July			
	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer Orders	33	4	10	4	2			
Output 1 → Projected on-hand inventory	61	61	61	61	51	41	31	21
Output 2 → MPS (planned production)	30	30	30	30	30	30	30	30
Available-to-promise (uncommitted)								
On hand inventory: 64								
Production Lot size = 30								
Safety stock = 5								

Due to the fact that we are dealing with Level Demand Strategy and have been told that the Fixed Batch quantity is 30, the MPS figures will be 30 units for every period regardless of the forecast.

Calculation of Inventory on-hand for period 1 is as follows: 64 (on-hand Inventory) – 33 (customer orders in period 1) + the MPS quantity of 30 in week 1 = 61 units

The projected on-hand inventory at the end of period 2 is 61. Calculation of Inventory on-hand for period 2 is as follows: 61 (on-hand Inventory end of period 1) – 30 (forecast in period 2) + the MPS quantity of 30 in week 2 = 61 units

The projected on-hand inventory at the end of period 3 is 61. Calculation of Inventory on-hand for period 3 is as follows: 61 (on-hand Inventory end of period 2) – 30 (forecast in period 3) + the MPS quantity of 30 in week 3 = 61 units

	June				July			
	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer Orders	33	4	10	4	2			
Output 1 → Projected on-hand inventory	61	61	61	61	51	41	31	21
Output 2 → MPS (planned production)	30	30	30	30	30	30	30	30
Available-to-promise (uncommitted)				▲	▲	▲	▲	▲
On-hand inventory: 64								
Production Lot size = 30								
Safety stock = 5								

The projected on-hand inventory at the end of period 4 is 61. Calculation of Inventory on-hand for period 4 is as follows: 61 (on-hand Inventory end of period 3) – 30 (forecast in period 4) + the MPS quantity of 30 in week 4 = 61 units

The projected on-hand inventory at the end of period 5 is 51. Calculation of Inventory on-hand for period 5 is as follows: 61 (on-hand Inventory end of period 4) – 40 (forecast in period 5) + the MPS quantity of 30 in week 5 = 51 units

The projected on-hand inventory at the end of period 6 is 41. Calculation of Inventory on-hand for period 6 is as follows: 51 (on-hand Inventory end of period 5) – 40 (forecast in period 6) + the MPS quantity of 30 in week 6 = 41 units

The projected on-hand inventory at the end of period 7 is 31. Calculation of Inventory on-hand for period 7 is as follows: 41 (on-hand Inventory end of period 6) – 40 (forecast in period 7) + the MPS quantity of 30 in week 7 = 31 units

The projected on-hand inventory at the end of period 8 is 21. Calculation of Inventory on-hand for period 8 is as follows: 31 (on-hand Inventory end of period 7) – 40 (forecast in period 8) + the MPS quantity of 30 in week 8 = 21 units

STEP 2: COMPLETION OF OUTPUT 3 (AVAILABLE TO PROMISE INVENTORY)

	June				July			
	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer Orders	33	4	10	4	2			
Projected on-hand inventory	61	61	61	61	51	41	31	21
MPS (planned production)	30	30	30	30	30	30	30	30
Output 3 Available-to-promise Inventory (uncommitted)	61	26	20	26	28	30	30	30
On hand inventory: 64								
Production Lot size = 30								
Safety stock = 5								

The customer orders in week 1 are 33. We do not sum the customer orders in week 2 because there is a MPS quantity in week 2.

The ATP for week 1 is 61 units which is calculated as follows:
 64 (Starting on-hand inventory) + 30 (Week 1 MPS Quantity) – 33 (Week 1 Customer orders) = 61 .

The customer orders in week 2 are 4. We do not sum the customer orders in week 3, because there is an MPS quantity in week 3.

The ATP for week 2 is 26 units and is calculated as follows: 30 (Week 2 MPS) – 4 (Week 2 Customer orders) = 26 .

The customer orders in week 3 are 10. We do not sum the customer orders in week 4, because there is an MPS quantity in week 4.

The ATP for week 3 is 20 units which is calculated as follows:
 30 (Week 3 MPS) – 10 (Week 3 Customer orders) = 20 .

The customer orders in week 4 are 4. We do not sum the customer orders in week 5, because there is an MPS quantity in week 5.

The ATP for week 4 is 26 units which is calculated as follows:
 30 (Week 4 MPS) – 4 (Week 4 Customer orders) = 26 .

The customer orders in week 5 are 2. We do not sum the customer orders in week 6 (even if there were), because there is an MPS quantity in week 6.

The ATP for week 5 is 28 units which is calculated as follows:
 30 (Week 5 MPS) – 2 (Week 5 Customer orders) = 28 .

There are no customer orders in week 6, 7 and 8, but since there are MPS quantities in each of these weeks, we need to calculate the ATP. The ATP equals the MPS quantities because of the fact that there are no customer orders for these weeks

- (5) Question 6. Note that the MPS drives the rest of the MRP process. It works out the volume and timing of assemblies, sub-assemblies and materials required to meet the master production schedule. The product structure will show the various parts that go into making the final or end product and, in MRP terms, it will break the finished product down into different levels of assembly. Level 0 is the finished product, level 1 the parts and sub-assemblies that go into making the finished product, level 2 the parts and sub-assemblies that go into level 1, etc. Study figures 14.6 in your prescribed book for an example of a board game known as "Treasure Hunt" and note the product structure and its breakdown into the various levels of assembly. The nature of the product structure is closely related to the design of the product itself and is reflected in the product structure shape, which is determined by the number of components and parts used at each level (the more components and parts used, the wider the structure would be) and the number of items made in-house and those bought incomplete and only requiring assembly. (A large number of bought-in assemblies will make the product structure "shallow" while a large number being manufactured in-house makes the product structure "deep".) Note the product structure stops when it gets down to parts that are not made by the particular organisation but are bought-in from another operation. Study figure 14.7 in your prescribed book and note the four different product structures and the typical operations associated with them. ("A" shape – only one finished product which goes into a greater number of components; "T" shape – small number of raw materials and a standard process with a very wide range of highly customised end products; "V" shape – like "T" shape, but with less standardisation; "X" shape – wide range of finished products with economy and stability of large volume production of modularised manufactured components.)
- (6) Question 7. The single-level bills of materials provide the details of the relationships between parts and sub-assemblies as one single level at a time – see table 14.4 in your prescribed book and note that the format is level 0, level 1 (all items under each other) and level 2 (all items under each other) while, for the indented bills of materials, the relationships for several levels at the same time are shown. See table 14.5 in your prescribed book and note the format is level 0, level 1 (individual items with its level 2 parts if applicable). Also study the worked-out example of "Novelty Pencil Company" in chapter 14 of your prescribed book. Do you agree with the suggested solution of translating the BOM information into a product structure?
- (7) Question 8. First note that the BOM provides the MRP with the base data on the "ingredients" or structure of the products. Rather than simply taking the "ingredients" and multiplying them with the number of items demanded, thereby determining the total material requirements, MRP recognises that some of the required items may be available in stock in the form of finished goods, work-in-progress or raw materials. MRP thus requires that inventory records be kept of these items in stock so that it is only necessary to determine the extra requirements (net requirements) needed to supplement the inventory for total demand. Three files kept in the MRP system help manage inventory, namely the item master file (contains the unique standard identification code for each part or component), the transaction file (which tracks the quantity of inventory of each part kept) and the location file (identifies where the parts of inventory are physically kept or stored).
-

7.4 MRP CALCULATIONS



ACTIVITY 7.4

Study the third section of chapter 14 in your prescribed book entitled "MRP calculations" (the MRP netting process) and then answer the questions and/or complete the following:

- (1) The core of the MRP procedure involves calculating and requirements.
 - (2) What is the purpose of the MRP netting process and how is the process performed (or carried out) in simple practical examples?
 - (3) Why is it necessary to back schedule the quantities required in MRP and how would this be done for simple, practical examples?
 - (4) Briefly explain MRP capacity checks and the three planning routines to check production plans against the operation's resources at three levels.
 - (5) What is the difference between materials requirements planning (MRP), manufacturing resource planning (MRP II) and enterprise resource planning (ERP)?
-



FEEDBACK: ACTIVITY 7.4

- (1) *Question 1. Although the core of the MRP procedure involves calculating the volume (how much), it is also primarily determining timing of orders in terms of "planned order releases" (when or at what time requirements) of materials that will satisfy the demand for the finished or end products.*
- (2) *Question 2. The MRP netting process takes the master production schedule and "explodes" the schedule through a single-level bill of materials to determine how many sub-assemblies or parts are required. Then, before moving to the next level down the product structure, it checks to see how many parts that are required are already in stock. It then generates work orders or requests for the net requirements of items made in-house and/or purchase orders for the net requirements for items that are bought-in from suppliers. Study figure 14.8 in your prescribed book for an illustration of the MRP netting process (for the various levels of a product structure) and figure 14.9 for the example of the "Treasure Hunt" board game.*

ANNEXURE 2

MATERIALS REQUIREMENTS PLANNING

The previous section in this Tutorial (master production scheduling) described the role of the master production schedule (MPS) in showing the **end items** that manufacturing intends to produce/assemble.

The **end items** produced/assembled from **components** that must be available in the right quantities and at the right time to meet the MPS requirements.

Materials requirements planning (MRP) helps us to establish an MRP schedule showing the components required at each level of the assembly and, based on lead times, calculates when these components will be needed.

This MRP schedule has three inputs including:

Input 1: The MPS Schedule

The MPS schedule indicates the **quantity** and **timing** of end items required. To see how this relates to the previous section discussed in this tutorial (master production scheduling), look at the first MPS schedule discussed in this section. The MPS indicates (on the basis of a chase strategy with fixed batch quantities of 70), that production is required in week 2, 5, 6, and 8

	June				July			
	1	2	3	4	5	6	7	8
MPS (planned production)		70			70	70		70

These end items could have been anything, but for the sake of obtaining clarity, let's assume they were tables. We therefore are required to produce/assemble 70 tables in weeks 2, 5, 6 and 8.

To do that, we need to know **the parts (and number thereof)** required to make 1 table. Hence, for an MRP schedule, we require Input 2.

Input 2: The bill of materials

Simplified, the Bill of Materials (BOM) is a listing of the **parts required** to produce/assemble 1 end item. It also includes the **quantities required of each part** to produce/assemble 1 end item.

In the case of a table, perhaps we would require 1 wooden table top, 4 wooden legs and 16 screws (4 per each wooden leg)

To assemble these tables, we need to order the respective parts (listed above), but before we order, it is imperative that we find out:

- (1) How much **stock we currently have** of the respective items.
- (2) The **lead times** of the various items (time between when we order the parts and when we receive the parts)

Hence, for an MRP schedule, we require Input 3.

Input 3: Inventory records

Inventory records supply two kinds of information. The first is called **Inventory status**. The second is called **planning factors**.

- (1) **Input 3.1: Inventory status** — How much material is available of each part for future demand
- (2) **Input 3.2: Planning factors** — Includes information such as order quantities, lead times, and safety stock

To assist us towards compiling MRP schedules there are **two tools** that assist towards this end:

Tool 1: Product structure tree

The product structure tree is a visual description of the requirements in a bill of materials, where all components are listed by levels.

Tool 2: Indented bill of materials

A table reflecting the following details for each part used in the production/ assembly of the end item

- Part level (determined by Tool 1: Product structure tree)
- Part number (provided)
- Part description (provided)
- Lead time (provided)
- Quantity required (determined with assistance from Tool 1: Product structure tree)

As can be seen from Tool 2, the **indented bill of materials**, some items reflected in this tool are calculated with the assistance of Tool 1, the **product structure tree**. It is

therefore necessary to first complete the product structure tree before you complete the **indented bill of materials**.

Against the backdrop of the underlying theoretical components to MRP schedules, the best means of practically explaining how to complete an MRP schedule is to carry out an example and explain the actions step by step.

MRP PROBLEM 1:

A company manufactures product A which is made up of one unit of B, and half a unit of C. Each unit of B is made up of one unit of D, two units of E, and one unit of F. Each unit of C needs half a unit of G and three units of H. The lead times to manufacture all these components are as follows:

- A 2 weeks
- B 1 week
- C 2 weeks
- D 2 weeks
- E 3 weeks
- F 1 week
- G 2 weeks
- H 1 week

All these parts have 20 units in stock. It is required to make 100 units of A for delivery in seven weeks time.

You are required to:

- (a) Draw up a product structure tree
- (b) Draw up an indented bill of materials for the product.
- (c) Draw up a gross materials requirements plan for the manufacturer of the product.
- (d) Construct a net materials requirements plan for the manufacturer of the product.

Before we begin the example, let's take a brief look to see whether we have all the necessary information relating to the three inputs.

Input 1: The MPS schedule

'It is required to make 100 units of A for delivery in seven weeks time'

Input 2: The bill of materials

'product A which is made up of one unit of B, and half a unit of C. Each unit of B is made up of one unit of D, two units of E, and one unit of F. Each unit of C needs half a unit of G and three units of H'

Input 3: Inventory records

Input 3.1 Inventory status:

'All these parts have 20 units in stock'

Input 3.2 Planning factors:

'The lead times to manufacture all these components are as follows'

- A 2 weeks,
- B 1 week
- C 2 weeks
- D 2 weeks
- E 3 weeks

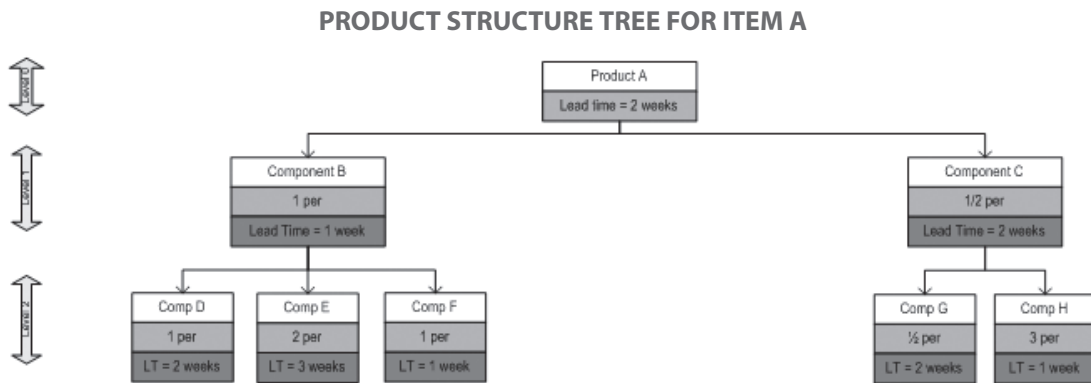
- F 1 week
- G 2 weeks
- H 1 week

We see from the above exercise, that according to the three types of inputs, we have all the necessary information in order to complete an MRP schedule for Product A.

Let's begin to answer the question:

(a) Draw up a product structure tree

To draw up a product tree, we need to source information from Input 2: The bill of materials and Input 3.2: The planning factors. We then break down the end item (Product A in this instance), level by level, to reflect the parts (and number thereof) required to produce/assemble the end item. The product structure for Product A is revealed below:



(b) Draw up an indented bill of materials for the product.

Indented bill of materials for:

Part:	Product A
Description:	None
Level:	0

Level	Part no	Description	Lead time	Quantity
0	A	None	2 wk	1
.1	B	None	1 wk	1
.1	C	None	2 wk	½
..2	D	None	2 wk	1
..2	E	None	3 wk	2
..2	F	None	1 wk	1
..2	G	None	2 wk	½
..2	H	None	1 wk	3

(c) Draw up a gross materials requirements plan for the manufacturer of the product.

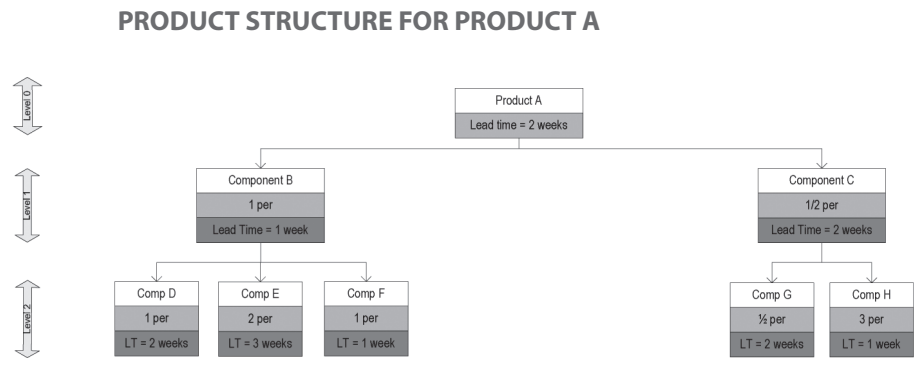
(d) Construct a net materials requirements plan for the manufacturer of the product.

Part (c) of the question required you to draw up a gross materials requirements plan (without taking available stock into account) and part (d) a net materials requirements plan (taking available stock into account). The combined MRP schedules that follow include the information relating to both (c) and (d). The information relating to (c) is included in the line item 'GROSS REQUIREMENTS' within the respective MRP schedules. The information relating to (d) is included in the line item 'PLANNED ORDER RELEASE' within the respective MRP schedules.

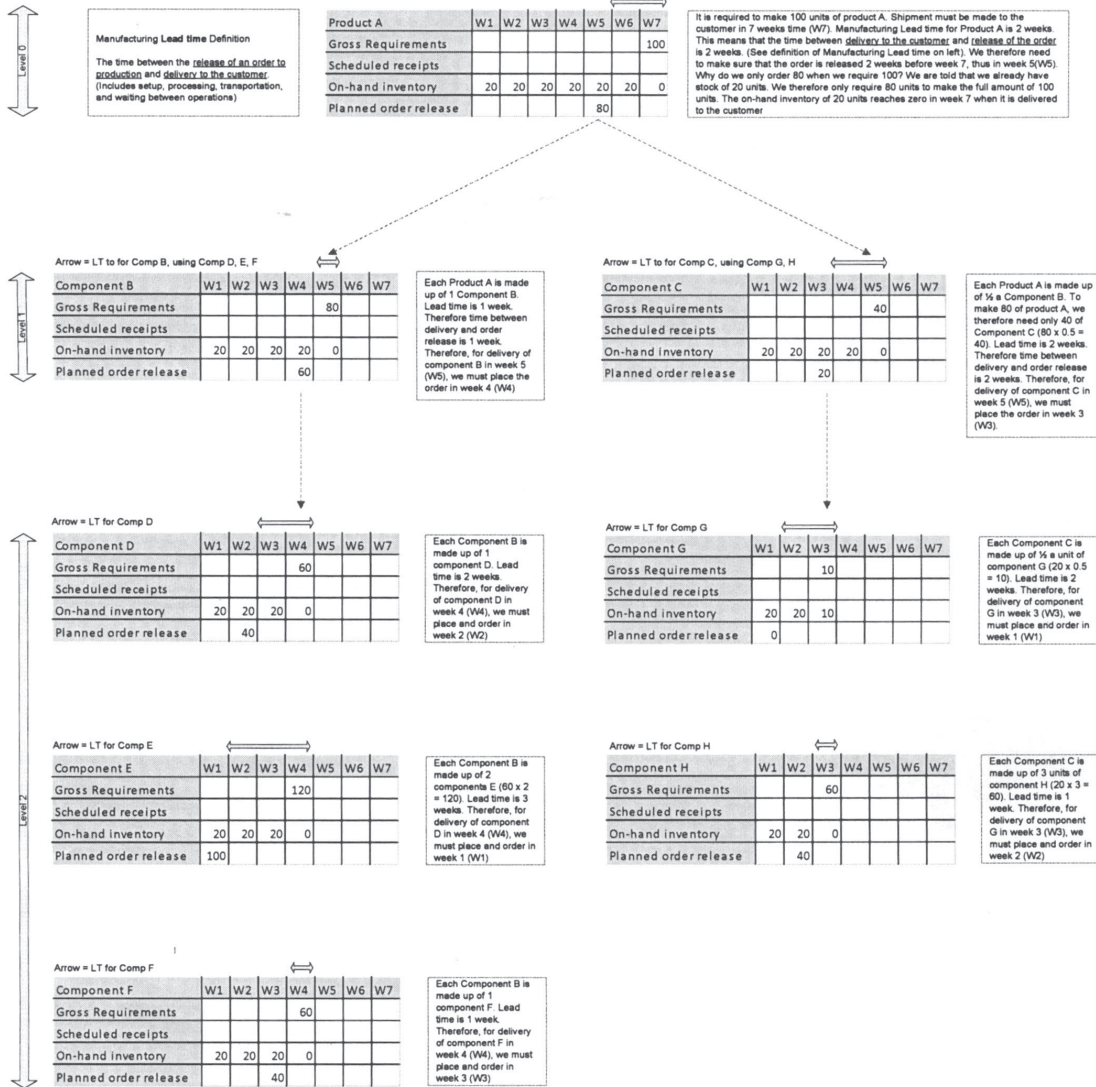
The Product Structure for A as well as the MRP SCHEDULES OF ALL PARTS (A to H) are all included on the next page.

By placing all the information on the same page, it is easier to adopt an understanding of the logic and flow of information through the various levels. Please read the answer thoroughly, level by level, and read the EXPLANATORY NOTES that accompany each MRP schedule on the right hand side.

Extra information has been included for the sake of EXPLAINING the logic.



MRP SCHEDULE CALCULATIONS (WITH EXPLANATIONS)



MRP PROBLEM 2:

Material requirements planning (MRP) is used to plan and control material requirements. The master production schedule (MPS) for three sizes of adjustable wrenches is given in the table below. All three adjustable wrenches (200 mm, 250 mm and 300 mm) use the same handle. The MPS requirements are:

	1	2	3	4	5
200 mm	5	5	3	9	
250 mm	18	5	20	6	20
300 mm	12		2		6
MPS	35	10	25	15	26

The inventory record (item master file) shows the following planning factors: batches are set at quantities of 20; safety stock is set at two handles; the available inventory is 70 and the lead time for orders is two weeks. When will the **first order** be issued (ie in which week) and what will the **available inventory** be in weeks 2 and 5 (ie quantity of items)?

Solution

Step 1

		1	2	3	4	5
Demand		35	10	25	15	26
On hand / Available	70	35	25			
Order						

Inventory = 70 as given in the question

On-Hand (70) - demand in week 1 (35) = 35

On-Hand week 1 (35) - demand in week 2 (10) = 25

Step 2

		1	2	3	4	5
Demand		35	10	25	15	26
On hand / Available	70	35	25	20		
Order		20				

On-Hand week 2 (25) - demand in week 3 (25) = 0. The question states that orders are in batches of **20** (lead time of two weeks) and safety stock is set at **2**. This means that "on hand" must be at least **2** and not **0** as in this case. An order of **20** must then be placed in week **1**. Thus on-Hand week 2 (25) - demand in week 2 (25) = 0 + order week 1 (20) = **20**

Step 3

		1	2	3	4	5
Demand		35	10	25	15	26
On hand / Available	70	35	25	20	5	
Order		20				

On-Hand week 3 (20) - demand in week 4 (15) = 5 (within the limit of safety stock which is 2 handles)

Step 4

		1	2	3	4	5
Demand		35	10	25	15	26
On hand / Available	70	35	25	20	5	19
Order		20		40		

On-Hand week 4 (5) - demand in week 5 (26) = -21. The question states that orders are in batches of **20** (lead time of two weeks) and safety stock is set at **2**. This means that "on hand" must be at least 2 and not -21 as in this case. An order of **40** must then be placed in week 3. Thus on-Hand week 4 (5) - demand in week 5 (26) = -21 + order week 3 (40) = **19**

- (3) Question 4. Note the closed-loop MRP includes a feedback loop whereby production plans are checked against available resources. Should the plans not be achievable at any level, they are revised through three planning routines. These are: resource requirements plans (RRP) (these focus on the long term to predict the requirements for large structural parts of the operation and are referred to as infinite capacity plans because they assume an almost infinite ability to set up production capacity if demands warrant it); rough-cut capacity plans (RCCP) (in the medium to short term, the MPS must use the capacity which is available and this plan checks the levels of capacity against known bottlenecks – these are referred to as finite capacity plans because they have to operate within certain constraints) and capacity requirements plans (CRP) (on a day-to-day basis the work orders may have a variable effect on the loading of particular machines and individual workers and these plans are also infinite capacity plans in so much as they do not take the capacity constraints of each machine or work area into account). Also study figure 14.10 in your prescribed book for an illustration of a closed-loop MRP with its three planning routines of RRP, RCCP and CRP.

- (4) Question 5. Note that MRP was essentially aimed at planning and control of production and inventory in manufacturing organisations which were extended to MRP II, whereby one integrated system containing a database was created which could be accessed by the whole business including marketing, finance and engineering. ERP is a further development of MRP II, where the aim is to “integrate the management of the different functions within the business as a whole in order to improve performance of all inter-related processes in a business”.
-

7.5 ENTERPRISE RESOURCE PLANNING (ERP)



ACTIVITY 7.5

Study the last two sections of chapter 14 in your prescribed book entitled: “Enterprise resource planning (ERP)” and “Web-integrated ERP” and then answer the questions and/or complete the following:

- (1) What does ERP entail, what are the benefits which could be expected from its implementation and why is it considered a “powerful” planning and control tool?
 - (2) What benefits can be expected from the further development of ERP in the form of web-integrated ERP and supply chain ERP?
 - (3) The OPT approach recognises the importance of planning to known capacity constraints and is based on the theory of constraints (TOC), which entails
 - (4) What are the principles of OPT and how would they be applied in a practical example?
 - (5) To what extent are OPT and MRP/ERP compatible?
-



FEEDBACK: ACTIVITY 7.5

- (1) Question 1. ERP is a complete system of software support modules through which marketing, sales, product design, production and inventory control, procurement, distribution, process design and development, manufacturing, quality, human resource, finance and accounting, etc are all integrated and share information with one another. The ERP discipline is seen as a “double-edged” sword. This is because information integration gives ERP much greater visibility which means that ERP keeps the management of every process within the organisation “on its toes” and allows for best practices. However, the rigidity of this discipline is both difficult to achieve and possibly not appropriate for all parts of the business. Generally accepted benefits include: absolute visibility of what is happening in all parts of the business; business process-based changes are used to make all parts of the organisation more efficient; a better “sense of control” of operations as the basis for continuous improvement; more sophisticated and accurate communication with customers, suppliers and other business partners; and integration of whole supply chains, including suppliers’ suppliers and customers’ customers. The reason why ERP is also considered a powerful planning and control tool is because it includes other features such as being based on client/server architecture (the information systems are open to all computers linked to the central computer), decision support facilities (operations decision makers have access to the latest company information), it can be linked to external extranet systems (the company’s supply chain partners through electronic data interchange [EDI]), it can interface with other standard application programmes (programmes which are widely used by managers like spreadsheets, etc), and it can operate on most common platforms (eg Windows). Probably the best-known ERP sys-

tem is the German company SAP's R/3 system. This is based on a three-tier client/server configuration (consisting of a network of databases which form the core of the system, a second-tier surrounding these databases which is a set of application servers which hold the basic logic flows and instructions, and third-tier front-end servers which are the individual computers of workstations). This has the following business applications: manufacturing and logistics, sales and distribution, financial accounting and human resources. Also read the case study "The life and times of a chicken salad sandwich – part two" in chapter 14 of your prescribed book and answer the questions at the end of the case study. Finally, study the critical remarks made by the authors of your prescribed book in chapter 14 regarding the implementation of ERP. Some companies achieved negative or even zero return on investment because of the high expense of the software and associated expenses of consulting, training, etc. Also, the implementation may have a potentially very disruptive impact – because the existing organisation has to change to fit the ERP system. We have heard similar criticism from organisations (public sector departments and private sector companies alike). However, we believe that most "negatives" could be countered or avoided with sound prior planning, training, etc. This would then pave the way for the organisation to enjoy the multitude of advantages accruing from an integrated planning and control system.

- (2) Question 2. Note that an ERP system gives the organisation the potential to link up with the "outside world" (its customers/clients and suppliers). It would be much easier for an organisation to move into internet-based trading (e-commerce) if it could integrate its external internet systems with its internal ERP systems. While problems of different information requirements (internal users, external customers/clients, suppliers, etc) may result in and lead to increased ERP complexity, the next step of moving beyond the integration of the internal ERP systems with immediate customers/clients and suppliers is to integrate all ERP systems along the whole supply chain ("supply chain ERP").
- (3) Question 3. The OPT (optimised production technology) approach recognises the importance of planning to known capacity constraints and is based on the theory of constraints (TOC) which entails focusing on the capacity constraints or bottleneck parts of an operation, working to remove them and then looking for the next constraint, etc in order to improve the pace of output or throughput. The work of Eliyahu Goldratt is well acknowledged in the development of the Theory of Constraints (TOC). We recommend his books: *The goal: a process of ongoing improvement*, *It's not luck* and *The critical chain*. They may be purchased through the National Productivity Institute, PO Box 3971, Pretoria, 0001, South Africa.
- (4) Question 4. Study the basic ten principles of OPT described by the authors of your prescribed book in chapter 14. Note that they primarily deal with production flow or throughput, bottlenecks, process batches and schedules.
- (5) Question 5. OPT should not be viewed as a replacement for MRP/ERP and they can run together, although, in practice, this may lead to conflict. MRP/ERP does not prescribe fixed lead times and batch sizes, although the systems are usually run that way. The focus on bottlenecks (which may change their location and severity because of the dynamic nature of unplanned variations in demand, supply and the process of manufacture), necessitates that lead times and batch sizes change throughout the operation (depending whether a particular work centre is a bottleneck or not).



CHECK LIST

Now that you have completed study unit 7 on materials requirements planning in operations, you should be able to do the following:

- Describe what enterprise resource planning (ERP) entails and how it has developed.

- Explain what the information input requirements of MRP are and what the outputs derived from these will be.
- Demonstrate that you can do MRP calculations.
- Describe what manufacturing resource planning (MRP II) entails and explain how ERP is developing including web-integrated ERP, supply chain ERP and optimised production technology (OPT).
- Use the knowledge, insight and skills you have attained of:
 - enterprise resource planning (ERP)
 - the information input requirements of MRP and the outputs derived from these
 - MRP calculations, and
 - manufacturing resource planning (MRP II) and ERP including web-integrated ERP, supply chain ERP and optimised production technology (OPT)

to justify its importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer either multiple-choice format or essay-type questions.

- Show that you appreciate the need for material requirements planning by explaining the theoretical concepts and demonstrating that you can apply the relevant production/operations skills in practice.



SUMMARY

This study unit examined enterprise resource planning in operations. It formed part of topic 4, which is entitled “Materials requirements planning”. It included a specific explanation of MRP as a “push” production and operations planning and control system, in contrast to the just-in-time or JIT “pull” system (see topic 5 and the next study unit, study unit 8). Based on known and forecast sales orders, MRP calculates the material requirements of end products contained in the master production schedule (both quantities and timing).



ASSESSMENT

- (1) Study the case study entitled “Psycho Sports Ltd” at the end of chapter 14 in your prescribed book and then answer the question.
- (2) Complete study activities 1 to 3 at the end of chapter 14 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, others may even require you to visit a local business/organisation to investigate an aspect of the subject for yourself.

TOPIC 5

JUST-IN-TIME PLANNING AND CONTROL

AIM

To provide you with an understanding of what just-in-time planning and control involve and why it is important for production and operations management.



LEARNING OUTCOMES

Once you have worked through this topic, you should be able to do the following:

- Describe the meaning of lean operations and JIT.
- Explain the lean philosophy.
- Explain the basic working practices or JIT techniques based on the overall lean philosophy, including how these ideas influence POM.
- Explain how JIT can be used in operation planning and control.
- Explain how JIT can be used in service operations.
- Explain the relationship between the JIT and MRP approaches to operation planning and control.
- Use your knowledge of, and insight into
 - the meaning of lean operations and JIT
 - the lean philosophy
 - the basic working practices or JIT techniques based on the overall lean philosophy, including how these ideas have influenced POM
 - JIT as used in the planning and control of operations
 - JIT as used in service operations
 - the relationship between the JIT and MRP approaches to operation planning and control

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you appreciate the need for just-in-time planning and control by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



TOPIC STUDY UNITS

Study unit 8 Lean operations and JIT
(chapter 15)

Study unit 8

LEAN OPERATIONS AND JIT



KEY CONCEPTS

lean or just-in-time (JIT)	lean operations
lean philosophy	buffer inventory
capacity utilisation	continuous improvement
elimination of waste	involvement of everyone
lean and Japanese practices	forms of waste
5-S terminology	throughput time
value stream mapping	respect for humans
Kaizen	JIT approach
JIT techniques	small machines
smooth flow	total productive maintenance (TPM)
reduce setup times	single minute exchange of dies (SMED)
JIT philosophy	Lamming's lean supply concept
Andon	adopt JIT through the supply chain
visibility	move or conveyance kanban
kanban control	vendor kanban
production kanban	levelled scheduling
single-card kanban system	Heijunka
levelled delivery schedules	mixed modelling
synchronisation	JIT and MRP
JIT in service operations	

GETTING AN OVERVIEW

This study unit covers the learning outcomes of topic 5. We shall discuss: the meaning of lean and just-in-time, the elements of the lean philosophy, the basic working practices or JIT techniques based on the lean philosophy, including how these ideas have influenced POM, JIT as used in the planning and control of operations, JIT as used in service operations, and the relationship between the JIT and MRP approaches to operation planning and control.

8.1 INTRODUCTION IN PRESCRIBED BOOK



READ

First read the introduction to chapter 15 in your prescribed book and note the basic composition of figure 15.1. This depicts a model of the lean operations and just-in-time planning and control activities in production/operations management. You need

to memorise this figure, because it serves as a mind map for the remainder of the study unit. After you have done this, read the points listed under the questions: “What is the lean approach and how is it different from traditional operations practice?”, “What are the main elements of the lean philosophy?”, “What are the techniques of JIT?”, “How can JIT be used for planning and control?”, “Can JIT be used in service operations?” and the points under the question “Can JIT and MRP coexist?” in the summary answers to the key questions at the end of chapter 15.

8.2 THE MEANING OF LEAN AND JUST-IN-TIME



ACTIVITY 8.1

Read the case study entitled “Toyota” in chapter 15 of your prescribed book and then answer the following questions:

- (1) The case refers to the TPS (Toyota Production System) which uses several methods to eliminate waste. Elaborate on these methods.
 - (2) What advantages did Toyota obtain from JIT?
-



FEEDBACK: ACTIVITY 8.1

- (1) Question 1. Toyota defines waste as anything other than the minimum amount of resources/equipment/material that is absolutely essential to production. They believe in both JIT and jidoka to eliminate waste. Processes and the way of doing things are constantly challenged and pushed to a higher level of performance.
 - (2) Question 2. Levelling and smoothing the flow of items can be singled out. On a higher strategic level the adoption of JIT as a manufacturing philosophy had certain direct and indirect benefits, which included innovation and improved performance. This included the “respect for people” or human approach (for example humanising the interface between operator and machine) and better teams, better management and a better environment for personal growth.
-



ACTIVITY 8.2

Study the first section of chapter 15 entitled “What is lean and just-in-time?” in your prescribed book and then answer and/or complete the following:

- (1) What do lean operations entail and on which principles are they based?
- (2) At its most basic, JIT literally means and in addition to this time-based element of JIT, it aims to
- (3) The fuller definition of JIT describes it as a disciplined approach to which provides for and is dependent on and is accomplished through the application of The key to the JIT philosophy is
- (4) What are some of the different phrases and terms to describe lean or JIT-type approaches and how does the JIT approach differ from traditional approaches to manufacturing?

- (5) If the idea of obscurity of inventory is illustrated, as in your prescribed book (figure 15.3), by a simple figure using the rocks in a river bed and a ship, what analogy (in terms of inventory) could be drawn if the depth of the water in the river was reduced and/or the rocks removed?
 - (6) What impact may the requirements of the JIT approach have on the production and operations performance objectives? How do traditional and JIT approaches to productive capacity utilisation differ?
 - (7) Based on the lean philosophy, what are the JIT tools and techniques that can be used for operation planning and control?
-



FEEDBACK: ACTIVITY 8.2

- (1) Question 1. *“Lean operations” represent a state of an operation where all waste has been eliminated, the operation is faster, more dependable and produces higher quality products and services and runs at low cost.*
 - (2) Questions 2 and 3. *These deal with the definition of JIT. Have another look at the discussion by the authors of your prescribed book in chapter 15.*
 - (3) Question 4. *Note that the lean or JIT approach is described by other terms such as continuous flow manufacture, high value-added manufacture, stockless production, fast through-put operating and short cycle time manufacturing. As far as the difference between the traditional and the JIT approach to manufacturing is concerned, revise the discussion by the authors of your prescribed book in chapter 15 and note the diagrammatic illustration of the distinction in figure 15.2.*
 - (4) Question 5. *Review the discussion by the authors of your prescribed book in chapter 15 and the illustration of the benefits of reducing inventory levels with the “ships sailing the sea” shown in figure 15.3.*
 - (5) Question 6. *Review the discussion by the authors of your prescribed book in chapter 15. Note the diagrammatic illustration of the different views of capacity utilisation in traditional and JIT approaches shown in figure 15.4.*
 - (6) Question 7. *Review the discussion by the authors of your prescribed book in chapter 15 and note the diagrammatic illustration of the lean philosophy of operations as the basis for JIT techniques, which include JIT methods of planning and control in figure 15.5 of your prescribed book.*
 - (7) *To summarise: Note that, in at least one way, the JIT approach to both manufacturing and service operations can be seen as a radical departure from the traditional approach. The emphasis in the traditional approach has been on high production and operations capacity utilisation and its accompanying negative impact on inventory. The JIT approach entails lower capacity utilisation with fewer inventory and associated problems.*
-

8.3 THE LEAN PHILOSOPHY



ACTIVITY 8.3

Study the second section of chapter 15 entitled “The lean philosophy” in your prescribed book and then answer and/or complete the following:

- (1) The lean philosophy of operations is the basis for JIT techniques that include JIT methods of planning and control. Explain this by means of a figure.
- (2) Explain the JIT approach to production and operations management in terms of waste.

- (3) What are the key issues which define the lean philosophy which, in turn, underpins the techniques of JIT?
 - (4) What seven forms of waste, identified by Toyota, were found to be prevalent in many different types of operations, both in production and service, and how does the JIT approach aim to eliminate them?
-



FEEDBACK: ACTIVITY 8.3

- (1) *The lean philosophy has three cornerstones namely the elimination of waste, involve everyone and continuous improvement. Study figure 15.5 as a good summary of what JIT entails.*
 - (2) *Question 2. The elimination of waste is central to lean approaches. Value-adding implies work-in-process must never be in a state of idleness. Make a list of typical types of waste (also refer to Toyota that identified seven types of waste). Note that, apart from the reducing buffer inventories between stages, thereby making each part more dependent on one another, other examples of high dependency are cited: empowering shop-floor staff, the use of the internal customer concept, the use of total productive maintenance and the JIT influence on supplier development policies.*
 - (3) *Question 3. This question deals with the lean philosophy of operations. Note the key issues which define the lean philosophy which, in turn, underpin the JIT principles. These are: (a) the elimination of all forms of waste; (b) the involvement of everyone in every process in the organisation; and (c) continuously striving to meet, instantaneously, and with no waste, the demand for products and/or services that are of perfect quality. Note the critical remarks made by the authors of your prescribed book in chapter 15 regarding firstly, taking the JIT principles to the extreme and secondly, not all people seeing JIT-influenced people management practices as positive. Do you agree with them? Also study the worked-out example of the ordinary flight to Durban and the calculation of value-adding activities and total elapsed time. Note the low proportion of time that value-adding activities add to the total elapsed time.*
 - (4) *Question 4. This question deals with the seven types of waste identified by Toyota. Review the discussion by the authors of your prescribed book in chapter 15. Briefly, waste involves over-production, waiting time, transport, process, inventory, motion and defective goods. Also study the case study entitled "Eternity Health Fund Administrators" in chapter 15 of your prescribed book and answer the question at the end of the case study.*
 - (5) *To summarise: Note that the three pillars of the JIT approach involve the elimination of all forms of waste, the involvement of everyone in every process in the organisation and continuously striving to meet, instantaneously, and with no waste the demand for products and/or services of perfect quality.*
-

8.4 THE TECHNIQUES OF THE JUST-IN-TIME APPROACH



ACTIVITY 8.4

Study the third section of chapter 15 entitled "JIT techniques" in your prescribed book and then answer and/or complete the following:

- (1) The "basic working practices" according to the JIT principles are
 - (a) discipline and standards which involve
 - (b) flexibility of working practices which involves,

- (c) equality of conditions which involves
 - (d) autonomy to intervene which involves
 - (e) development of personnel which involves
 - (f) quality of working life (QWL) which involves, and
 - (g) creativity which involves
- (2) What do each of the following JIT techniques involve and how do they contribute to the overall aims of JIT? Design for ease of processing; emphasising operations focus; using small, simple machines; layout for smooth flow; adopting total productive maintenance (TPM); reducing set-up times; ensuring visibility; and adopting JIT through the supply chain.
 - (3) How can lean ideas contribute to POM in the following key production/operations decision areas? Production/operations strategy, process design, product/service design, supply strategy and supply chain management, layout, process technology, job design, process planning and control, inventory, improvement, maintenance, and quality management.
-



FEEDBACK: ACTIVITY 8.4

- (1) Question 1. This question deals with the basic working practices. Review the discussion by the authors of your prescribed book in chapter 15.
 - (2) Question 2. This question deals with a number of JIT techniques. Review the discussion by the authors of your prescribed book in chapter 15. Note the diagrammatic illustration showing the use of several smaller machines rather than one large one in figure 15.7 of your prescribed book. Further, note Lamming's lean supply concept as described by the authors of your prescribed book in chapter 15, which includes table 15.1, where a number of factors and characteristics of lean supply chains are illustrated.
 - (3) Question 3. It is believed that the lean philosophy have been the single most positive influence on operations management in the last 50 years. Review the discussion by the authors of your prescribed book in chapter 15 and study table 15.2.
 - (4) To summarise: Note that many techniques which have previously been referred to and/or described in some study units in MNO2601 and this module (including the following study units) are also termed JIT techniques because of their natural and logical connection and/or contribution to the overall JIT philosophy. These, together with those highlighted in this study unit, provide a comprehensive set of tools which production and operations managers can use in their attempts to continuously improve their operations.
-

8.5 JUST-IN-TIME PLANNING AND CONTROL



ACTIVITY 8.5

Study the fifth section of chapter 15 entitled "Just-in-time planning and control" in your prescribed book and then answer and/or complete the following:

- (1) In terms of inventory timing, JIT is a "pull system" which means and it differs from MRP which is a system.
- (2) What does kanban control involve and how are move or conveyance kanban, production kanban and vendor kanban used in operations?
- (3) How does a single-card kanban system work and what are the rules which govern the use of kanbans?

- (4) What does levelled scheduling or Heijunka (to use the Japanese word) involve? How can it be used in a practical setting to reduce the batch sizes of, say, the manufacture of three products, A, B and C, and make the production schedule more visible and transparent to all involved?
 - (5) How may levelled delivery schedules contribute to lower inventory levels?
 - (6) On what principle is mixed modelling based and how can it be used in a practical setting to determine the sequence of individual products such as the manufacture of three products, A, B and C, where the economic batch quantity (EBQ) equals the JIT ideal of one?
 - (7) What does synchronisation entail and how is the manufacture of products or parts classified as “runners”, “repeaters” and “strangers” synchronised in a production process to reduce the variability of timing intervals for such products or parts?
-



FEEDBACK: ACTIVITY 8.5

- (1) Questions 1 to 3. These deal with JIT planning and control. Review the discussion by the authors of your prescribed book in chapter 15. Specifically note the diagrammatic illustration of a single-card kanban system in figure 15.8 of your prescribed book.
 - (2) Questions 4 to 7. These deal with levelled scheduling, levelled delivery schedules, mixed modelling and synchronisation. Review the discussion by the authors of your prescribed book in chapter 15. Specifically note the diagrammatic illustration of levelled scheduling versus a schedule in large batches (figure 15.9). Also study the worked-out example of the manufacturing of products A, B and C and the determination of sequence which delivers the correct number of products per cycle period in chapter 15. Do you agree with the calculation?
 - (3) To summarise: note that kanban control, levelled scheduling, mixed modelling and synchronisation are all JIT techniques. These techniques deal specifically with planning and control activity in operations, where the focus of concern is “when to manufacture and how much”.
-

8.6 THE JUST-IN-TIME APPROACH IN SERVICE OPERATIONS



ACTIVITY 8.6

Study the sixth section of chapter 15 entitled “JIT in service operations” in your prescribed book and then answer and/or complete the following:

- (1) The principles and techniques of JIT are just as applicable to service operations as they are to manufacturing operations because
 - (2) What are the similarities between inventory (in the case of manufacturing operations) and queues (in the case of service operations) where JIT had an effect on the first in terms of improvement and problemsolving and, indeed, was largely the reason for its use in the first place?
-



FEEDBACK: ACTIVITY 8.6

- (1) Questions 1 and 2. These questions deal with JIT in service operations. Review the discussion by the authors of your prescribed book in chapter 15. Specifically note the diagram-

matic illustration of the analogous aspects of inventory and those of queues in table 15.3 of your prescribed book. Also read the case study of “Have a cappuccino?” in chapter 15 of your prescribed book and answer the question at the end of the case study.

- (2) To summarise: Note that JIT may have as many benefits for, and improve service operations as much as it does traditional manufacturing environments. In fact, the general trend that can be deduced from this and many other examples is that service operations need effective production and operations management just as much as typical manufacturing operations.
-

8.7 JUST-IN-TIME (JIT) AND/OR MATERIAL REQUIREMENTS PLANNING (MRP)



ACTIVITY 8.7

Study the seventh section of chapter 15 entitled “JIT and MRP” in your prescribed book and then answer and/or complete the following:

- (1) The operating philosophies of JIT and MRP seem to be fundamentally opposed. JIT encourages a ... system and aims which are, while MRP is a system and essentially only a mechanism.
 - (2) What are the similarities and differences between JIT and MRP and how can these two approaches coexist in the same operation?
 - (3) How can JIT and MRP be used as separate systems in an operation for different products and how can MRP be used for overall control and JIT for internal control of one particular operation?
 - (4) When should pure versions of JIT and MRP or one of the options combining the two be used in operations? How can the complexity determinant be used to make such a decision?
-



FEEDBACK: ACTIVITY 8.7

- (1) Questions 1 and 2. These questions deal with the operating philosophies of MRP and JIT. These also cover the key characteristics, similarities and differences of both. Review the discussion by the authors of your prescribed book in chapter 15.
 - (2) Question 3. This question deals with the use of JIT and MRP as separate systems or using MRP for overall control and JIT for internal control. Review the discussion by the authors of your prescribed book in chapter 15.
 - (3) Question 4. Specifically, study figure 15.11 and how the level of complexity is a determinant of these two different types of systems.
 - (4) To summarise: Note that it is thus not simply a clear-cut case of “the one or the other” in deciding when to use JIT or MRP. In some operating environments the use of the “pure” versions of each may be appropriate. In others, one of the combined versions of JIT and MRP may be more suitable. In other environments, neither is appropriate and nor is a combination of the two.
-



CHECK LIST

Now that you have completed study unit 8 on lean operations and JIT, you should be able to do the following:

- Describe the meaning of lean operations and JIT.
- Explain the lean philosophy.
- Explain the basic working practices or JIT techniques based on the overall lean philosophy, including how these ideas have influenced POM.
- Explain how JIT can be used in operation planning and control.
- Explain how JIT can be used in service operations.
- Explain the relationship between the JIT and MRP approaches to planning and control of operations.
- Use your knowledge of, and insight into
 - the meaning of lean operations and JIT
 - lean philosophy
 - the basic working practices or JIT techniques based on the overall lean philosophy, including how these ideas have influenced POM
 - JIT as used in the planning and control of operations and how lean ideas have influenced POM
 - JIT as used in service operations
 - the relationship between the JIT and MRP approaches to planning and control of operations

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- demonstrate that you appreciate the need for just-in-time philosophy in practice by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



SUMMARY

This study unit examined the just-in-time philosophy in action. Our discussion showed that JIT, as a planning and control approach to operations, deals with much more than only inventory timing, although a fundamental part of the JIT approach is based on the idea of satisfying customers'/clients' demands for products and/or services instantaneously or just in time. The complete JIT philosophy of operations embraces core ideals of eliminating waste, involving everyone in the business and continuous improvement. Several JIT techniques are available to production and operations managers, amongst them the seven basic working practices of discipline and standards, flexibility, equality of conditions, autonomy to intervene, development of personnel, quality of working life (QWL) and creativity. In addition, there are the approaches of design for manufacture, operations focus, small simple machines, layout and flow, total productive maintenance, set-up reduction, total people involvement, visibility and JIT supply.



ASSESSMENT

- (1) Read the case study entitled “Boys and Boden” at the end of chapter 15 in your prescribed book and then answer the question.
- (2) Complete study activities 1 to 4 at the end of chapter 15 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, others may require you to visit a local business/organisation to investigate an aspect of the subject for yourself.

TOPIC 6

QUALITY PLANNING AND CONTROL

AIM

To provide you with an understanding of what quality planning and control entails and why it is important for production and operations management.



LEARNING OUTCOMES

Once you have worked through this topic, you should be able to do the following:

- Describe what quality a POM performance objective entails and explain why it is regarded as important.
- Describe what the key production and operations responsibility regarding conformance to specifications involves.
- Explain how the quality planning and control activity may be used to ensure that products and/or services conform to their design specifications.
- Describe what statistical process control (SPC) entails and explain how it may be used to monitor variations in process quality and drawing up control charts for attributes and variables.
- Describe how the role of process control has changed with learning and process knowledge and explain the use and workings of the Six Sigma quality approach.
- Describe what acceptance sampling (AS) entails and explain how it can be used to draw up an acceptance sampling plan.
- Use your knowledge of, and insight into
 - quality as a POM performance objective
 - the key production and operations responsibility in respect of conformance to specifications and the quality planning and control activity to ensure that products and/or services conform to design specifications
 - statistical process control (SPC) used to monitor variations in process quality and in drawing up control charts for attributes and variables
 - the changed role of process control as a result of learning and process knowledge with the Six Sigma quality approach
 - acceptance sampling (AS) as used to draw up an acceptance sampling plan

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you appreciate the need for quality planning and control by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.
-



TOPIC STUDY UNITS

- Study unit 9 Assuring quality in production and operations management systems (chapter 17)
- Study unit 10 Statistical process control (SPC), Six Sigma and acceptance sampling (chapter 17)
-

Study unit 9

ASSURING QUALITY IN PRODUCTION AND OPERATIONS MANAGEMENT SYSTEMS



KEY CONCEPTS

closing quality gaps	concept – specification range
conformance to specification	consistent conformance
customer's/client's expectations	customers'/clients' perception of quality
customers'/clients' specification	customers'/clients' view of quality
operation's specification gap	manufacturing-based approach to quality
definitions of quality	product-based approach to quality
measuring quality characteristics	quality characteristics
operation's view of quality	quality specification – actual quality gap
quality assurance	statistical process control (SPC)
quality gaps	type I errors
quality standards	user-based approach to quality
start/during/after process checks	variables and attributes
transcendent approach to quality	
type II errors	
value-based approach to quality	

GETTING AN OVERVIEW

This study unit covers the first two learning outcomes of topic 6. We shall discuss quality as a POM performance objective (what quality is and why it is important) and the key production and operations responsibility regarding quality characteristics and conformance to specifications.

9.1 INTRODUCTION IN PRESCRIBED BOOK



READ

First read the introduction to chapter 17 in your prescribed book and note the basic composition of figure 17.1. This depicts a model of quality planning and control activities in production/operations management. You need to memorise this figure because it serves as a mind map for the remainder of the study unit. After you have done this, read the points listed under the questions: "How can quality be defined?", "How can quality problems be diagnosed?" and "What steps lead to conformance to specification?" in the summary answers to key questions at the end of chapter 17.

9.2 DEFINITIONS OF QUALITY



ACTIVITY 9.1

Read the case study entitled “Quality at Four Seasons Hotel Canary Wharf” in chapter 17 of your prescribed book and then answer the following questions:

- (1) What guiding principle did the group adopt and how did this contribute to its success?
 - (2) How does the “guest history system” help to “delight customers”?
-



FEEDBACK: ACTIVITY 9.1

- (1) *Question 1. Ever since it started, the hotel group adopted the same guiding principle, namely “to make the quality of our service our competitive advantage”. Although this is a simple rule, it was used to guide the whole organisation’s approach to quality. The hotel group is well recognised for its quality of service and has won numerous awards including, recently, a very coveted award: the international “top hotel chain”.*
 - (2) *Question 2. The hotel group emphasises what it calls “exceptional basics”, which means getting all the important things right: a comfortable bed, finest sheets, blackout curtains, etc. Furthermore, the group keeps track of guests’ preferences, such as particular fruit or wine and makes sure these are available when guests make a return visit. The objective of the hotel group is to exceed their guests’ expectations.*
-



ACTIVITY 9.2

Study the first section of chapter 17 entitled: “What is quality and why is it so important?” in your prescribed book and then answer and/or complete the following:

- (1) Quality is regarded as important for most operations because better quality improves profitability. In the case of revenues, higher quality can and in the case of costs, it can
 - (2) How does each of the following approaches define quality? The transcendent approach; the manufacturing-based approach; the user-based approach; the product-based approach; and the value-based approach.
 - (3) The operation’s view of quality defines it as
 - (4) How can the definition of the operation’s view of quality be reconciled with the definitions of the manufacturing-based, the user-based, the product-based and the value-based approaches?
 - (5) What is the significant implication of defining quality as “conformance to customers’ expectations” rather than conformance to customers’ wants or needs?
 - (6) What is the customer’s view on quality and how does this complicate a clear-cut definition of quality in terms of the individual customer’s perception?
 - (7) How can the four quality gaps be illustrated in a diagram? What does each of the following perceived quality gaps involve? Gap 1: the customer’s specification-operation’s specification gap; gap 2: the concept-specification gap; gap 3: the quality specification-actual quality gap; and gap 4: the actual quality-communicated image gap.
 - (8) What is the possible effect on the organisation and/or clients/customers if there is a quality gap and which part of the organisation is mainly responsible for preventing each of the four perceived quality gaps?
-



FEEDBACK: ACTIVITY 9.2

- (1) Question 1. This question deals with the importance of quality. Review the discussion by the authors of your prescribed book in chapter 17 and specifically study figure 17.2, which illustrates the beneficial effect of higher quality on both revenues and costs.
 - (2) Questions 2 to 6. These questions deal with various approaches to quality, including reconciling the operation's view with the customer's view of quality. Review the discussion by the authors of your prescribed book in chapter 17. Note the diagrammatic illustration in figure 17.3 in your prescribed book. This figure clearly shows how the perceptions of "quality is poor" (expectations > perceptions) and "quality is good" (expectations < perceptions) develop. Finally, read the case study of "Tea and Sympathy" in chapter 17 of your prescribed book and answer the questions at the end of the case study.
 - (3) Questions 7 and 8. These questions deal with the diagnosis of quality problems, identifying quality gaps and the responsibility of closing these gaps. Review the discussion by the authors of your prescribed book in chapter 17. Study figure 17.4 in your prescribed book which illustrates the customer's/client's domain and operation's domain in determining "perceived quality". (This is determined by a comparison of the customer's/client's expectations of a product or service and the customer's/client's perception of the particular product or service.) See also table 17.1, which indicates which organisational function or functions are mainly responsible for correcting or closing quality gap/s.
 - (4) To summarise: Note that, today more than ever, quality of product and/or quality of service is of vital importance to any organisation. Indeed, we could argue that high quality goods and services give an organisation a definite competitive edge. In other words, quality constitutes the single most important factor in setting an organisation apart from its competitors, and ensuring its very survival in what is expected to be an extremely competitive 21st century. However, defining what quality is, to everybody's satisfaction and/or in accordance with their personal preferences, is more difficult than it may seem. This is because every individual customer/client has his or her own idea or perception of what a quality product and/or service is or should be like. Such perceptions are formed and shaped by past experiences, individual knowledge and history – all of which may differ from individual to individual. Quality, from the viewpoint of production and operations management, provides a working definition – "Quality is consistent conformance to customers' expectations" – but it may still be difficult to quantify, although the concept of perceived quality gaps makes it more meaningful.
-

9.3 CONFORMANCE TO SPECIFICATIONS



ACTIVITY 9.3

Study the second section of chapter 17 entitled: "Conformance to specification" in your prescribed book and then answer and/or complete the following:

- (1) Conformance to specification means and production and operations managers carry most of the responsibility for eliminating gap 3 of the perceived quality gaps, which is
- (2) How can the model of the product/service design cycle be extended to include quality planning and control and which six steps will this involve?
- (3) What does step 1 of quality planning and control, namely defining the quality characteristics, entail? How would the following six characteristics feature in, for example, the manufacturing of a motor vehicle or booking an air ticket: functionality, appearance, reliability, durability, recovery, and contact?

- (4) What does step 2 of quality planning and control, namely deciding on how to measure each quality characteristic, involve? How would the quality characteristics of functionality, appearance, reliability, durability, recovery, and contact be measured (both variables and attribute measures) in, for example, the manufacturing of a motor vehicle or booking an air ticket?
 - (5) What does step 3 of quality planning and control, namely setting quality standards, involve and how would one set quality standards for, say, the manufacture of a car or an airline journey?
 - (6) What does step 4 of quality planning and control, namely controlling quality against quality standards, involve and what are the three main aspects of this task?
 - (7) What is the purpose of doing checks at critical control points such as (a) at the start of the process, (b) during the process, and (c) after the process?
 - (8) Why is it impractical (although it may seem like the ideal) to check every single product coming off the production line or every service delivered? Why would doing this still not guarantee that all defects or problems were detected?
 - (9) What is involved in type I and type II errors that may occur when a sample is used on which to base a decision about the quality of products or services? How could these errors occur in decisions relating to, say, the manufacture of a motor vehicle or booking an air ticket?
 - (10) Which two basic quality planning and control methods can be used to check the quality of a sample product or service and under which circumstances would each be used?
-



FEEDBACK: ACTIVITY 9.3

- (1) Question 1. This question deals with conformance to specification. Review the discussion by the authors of your prescribed book in chapter 17.
 - (2) Question 2. This question deals with how the model of the product/service design cycle can be extended to cover quality planning and control. Review the discussion by the authors of your prescribed book in chapter 17.
 - (3) Questions 3 to 5. These questions deal with the sequential steps of quality planning and control. Review the discussion by the authors of your prescribed book in chapter 17. Note the examples of quality characteristics for a car and air journey as illustrated in table 17.2, and for an online grocery shopping service as illustrated in figure 17.5. Furthermore, note the variable and attribute measures that are used to measure the quality of the car manufacture and air journey as illustrated in table 17.3. Finally, read the case study of “Quality at Groot Constantia” in chapter 17 of your prescribed book and answer the questions at the end of the case study.
 - (4) Questions 6 to 10. These questions deal specifically with step 4 – controlling quality against standards. Review the discussion by the authors of your prescribed book in chapter 17. Note the distinction between type I and type II errors for the example of a pedestrian crossing the road, as illustrated in table 17.4 of your prescribed book. Finally, read the case studies of “Security scanning” and “Surgical statistics” in chapter 17 of your prescribed book and answer the questions at the end of each case study.
 - (5) To summarise: Note that the quality planning and control activity involves six steps. The first four, namely defining the quality characteristics, deciding on how to measure each characteristic, setting quality standards for each characteristic, and controlling quality against these standards, were examined in this study unit. The other two steps, namely step 5 – finding and correcting causes of poor quality and step 6 – continuously making improvements, are dealt with in part III of this study guide.
-



CHECK LIST

Now that you have completed study unit 9 on ensuring quality in production and operations management systems, you should be able to do the following:

- Describe what quality entails and explain why it is regarded as important.
- Describe what the key production and operations responsibility in terms of conformance to specifications involves.
- Explain how the quality planning and control activity can be used to ensure that products and/or services conform to their design specifications.
- Use your knowledge of, and insight into
 - quality as a POM performance objective
 - the key production and operations responsibility regarding conformance to specifications and the quality planning and control activity as used to ensure that products and/or services conform to design specifications

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you appreciate the need for quality in production and operations management systems by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



SUMMARY

This study unit examined how to ensure quality in production and operations management systems. We proposed a working definition of what quality entails in production and operations management systems; then we noted that the perceived quality gap model provides a diagnostic tool for identifying quality problems. Part of the quality planning and control activity of production and operations management involves defining quality characteristics, deciding on how to measure them, setting standards for acceptable or unacceptable performance and then controlling the quality of the operation against these standards.



ASSESSMENT

- (1) Read the case study entitled “Levi’s: Quality is in the eye of the beholder” at the end of chapter 17 in your prescribed book and then answer questions 1 and 2.
- (2) Complete study activities 1 and 2 at the end of chapter 17 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, others may even require you to visit a local equivalent business/organisation to investigate an aspect of the subject yourself.

Study unit 10

STATISTICAL PROCESS CONTROL (SPC), SIX SIGMA AND ACCEPTANCE SAMPLING



KEY CONCEPTS

acceptance sampling plan
acceptance number of defects in sample = c
average range \bar{R}
common causes
control charts for attributes
control limits
 $C_{pk} = \min(C_{pu}, C_{pl})$
LCL formula for attributes
LCL formula for sample means
lower one-sided index (Cpl)
natural variation
operating characteristic (OC)
process capability
proportion incorrect (\bar{p})
sample average or mean (\bar{X})
sample size (n)
type I and II errors in SPC
UCL formula for range chart
upper control limit (UCL)
variation in process quality
Six Sigma-based improvement concept
defect
defect opportunity
process yield
defects per opportunity
Sigma measurement
Taguchi loss function
 $L = D^2C$
D = deviation from target performance
producer's risk = type I error in acceptance sampling
operating characteristic (OC)
lot tolerance percentage defective (LTPD)

acceptance sampling (AS)
assignable causes of variation
capability (Cp)
chart
consumer's risk
control charts
control charts for variables
process average (\bar{X})
LCL formula for range chart
lower control limit (LCL)
mean proportion defective (\bar{p})
one-sided capability indices curve
producer's risk
R chart
sample size = n
statistical process control (SPC)
UCL formula for attributes
UCL formula for sample means
upper one-sided index (Cpu)
Six Sigma quality approach
Six Sigma as broad improvement
defects per million
defect unit
proportion defective
defect per unit (DPU)
defects per million opportunities (DPMO)
Quality Loss Function (QLF)
L = total loss to society costs
C = a constant value
target-oriented quality philosophy
consumer's risk = type II error in acceptance sampling
acceptable quality level (AQL) curve

GETTING AN OVERVIEW

Study unit 10 covers the third, fourth and fifth learning outcomes of topic 6. We shall discuss statistical process control (SPC) as used to monitor the variation in process quality and draw up control charts for attributes and variables; the changed role of process control with learning and process knowledge and using the six sigma quality approach; and acceptance sampling as used to draw up an acceptance sampling plan.

10.1 INTRODUCTION IN PRESCRIBED BOOK



READ

Again read the introduction to chapter 17 in your prescribed book and note the basic composition of figure 17.1. (As mentioned, this depicts a model of quality planning and control activities in production/operations management and you need to memorise this figure because it serves as a mind map for the remainder of the study unit.) After you have done this, read the points listed under the question: "How can statistical process control help quality planning and control?", and the points listed under the question: "How can acceptance sampling help quality planning and control?" in the summary answers to the key questions at the end of chapter 17.

10.2 STATISTICAL PROCESS CONTROL (SPC)



ACTIVITY 10.1

Study the third section of chapter 17 entitled "Statistical process control (SPC)" in your prescribed book and then answer and/or complete the following:

- (1) SPC is concerned with checking a product or service at creation, and this has the advantage that
- (2) What role do control charts play in SPC?
- (3) What is the significance of common causes of variation in process quality? How can normal distribution be used to describe the natural variation of a process?
- (4) What would the effect on an operation be in the case where the tolerance or specification range of a product is either smaller or larger than the natural variation of the process used to produce it?
- (5) Process capability is a measure of and the simplest way to calculate it is by means of the formula My own practical example of such a calculation is
- (6) How can one illustrate, diagrammatically, the process capability when compared with the natural variation of the process if the measure of process capability (C_p) value is greater than 1, equal to 1 or smaller than 1?
- (7) In the case of one-sided capability, the upper one-sided index is calculated by the formula, the lower one-sided index by the formula and, where only the lower of the two one-sided indices for a process is used to indicate its capability (C_{pk}), with the formula My own practical example of such a calculation is

- (8) What is the difference between common causes of variation and assignable causes of variation? How is each dealt with in terms of quality control?
- (9) How can control limits be used in control charts to monitor the occurrence of assignable causes of variation in a process? What are the implications of type I and type II errors in SPC?
- (10) Why are upper control limits (UCL) and lower control limits (LCL) for control charts normally set at three standard deviations away from the mean of the distribution? In terms of type I errors, what would the implications be if the limits were set at either one or two standard deviations respectively?
- (11) How does the Taguchi loss function propose to counter the two main criticisms levelled at SPC? (SPC assumes that any process performance which lies within the control limits is equally acceptable; trying to keep performance within control limits may indicate that the process is not deteriorating, but it does not help the process to improve.) Why is variability a “bad” thing?
- (12) When using a control chart for attributes, the average of the proportion defectives (p) is calculated by the formula, one standard deviation can then be estimated by the formula, the UCL is set as and LCL as (**Note:** LCL must not be negative and, when calculated as being so, must be rounded off to 0.) My own practical example of such a control chart with calculations is
- (13) When using a control chart for variables, the grand average or population mean (\bar{X}) is calculated by the formula, the average range (\bar{R}) can then be estimated by the formula For the sample means chart, the UCL is calculated by the formula and LCL with the formula For range charts, the UCL is calculated with the formula and LCL with the formula My own practical example of such a \bar{X} control chart and an R control chart with calculations is
- (14) Why are two types of control chart (namely, \bar{X} and R-charts) used in statistical process control for variables? Why is it necessary to look up the factors for A_2 , D_3 and D_4 in a table such as table 17.6 in your prescribed book in order to calculate the UCL and LCL of these control charts?
- (15) How should control charts for attributes and variables be interpreted? What does each of the six charts in figure 17.15 of your prescribed book imply in terms of investigating the process?



FEEDBACK: ACTIVITY 10.1

- (1) Questions 1 to 8. These questions deal with statistical process control. Review the discussion by the authors of your prescribed book in chapter 17. Note the illustration of charting (which applies to both variable and attribute quality measures) in figure 17.6 and the illustration of the natural variation (in the example of a rice-filling process) in figure 17.7 in your prescribed book. Also note the various illustrations of process capability and their values (ie $C_p > 1$, $C_p = 1$, $C_p < 1$) when compared with the natural variation of the process with a particular specification range (as required of the process shown in figure 17.8). Study the worked-out example of the process of filling boxes in chapter 17 of your prescribed book and indicate whether you agree with the calculation and come to a definite conclusion about the result obtained.
- (2) Questions 9 and 10. These questions deal with control charts and type I and II errors in SPC. Review the discussion by the authors of your prescribed book in chapter 17. Note the illustration of a control chart as an example of the impact resistance of door panels with control limits (figure 17.9). Also study table 17.5 in your prescribed book and note

the decision to either stop a process or leave it alone, given that the actual process may either be in or out of control in combination with the occurrence of type I and type II errors. Finally, study the critical remarks made by the authors of your prescribed book concerning criticisms of SPC. Do you agree with the authors of your prescribed book?

- (3) Question 11. This question deals with Taguchi's loss function. Review the discussion by the authors of your prescribed book in chapter 17. Note the difference between the traditional/conventional (left-hand diagram) and Taguchi approaches (right-hand diagram) to interpreting process variability as illustrated in figure 17.10 in your prescribed book (where a narrower band of acceptance variability is targeted which is sometimes called target-oriented quality philosophy). Also study figure 17.11 in your prescribed book, which illustrates both the fact that a narrower band of natural variation is better and that any changes in the behaviour of the process will be more easily noticed and easier to understand. Finally, read the case study example of "Safety and Quality are interlinked" and answer the questions at the end.
- (4) Questions 12 to 15. These questions deal with control charts for attributes and control charts for variables. Review the discussion by the authors of your prescribed book in chapter 17 and study the worked-out example of the credit card company in chapter 17. Do you agree with the calculation of the control limits (upper and lower p) and control chart (p -chart) in figure 17.12? Note that sometimes it is more convenient to plot the actual number of defects (c) rather than the proportion (or percentage) of defects (p). In such a case, a c -chart is used and in this case the process mean \bar{c} and control limits are calculated with the formulas as shown at the end of this particular worked-out example of the credit card company. Also study the worked-out example of GAM in chapter 17 of your prescribed book. Do you agree with the calculation (upper and lower \bar{X} and r) of the control limits and control chart (\bar{X} and R charts) shown in figure 17.14? In this case, both the process mean (\bar{X} chart) and process range (r -chart) can change over time (as illustrated in fig 17.13). Also note that, in the case of the calculation of the control limits for \bar{X} and R charts, the values for the constants A_2 , D_3 and D_4 must be used, given the particular sample size n which is used. These values are shown in table 17.6 in your prescribed book. Note that these values will be given to you if a question like this is asked in the examination. Finally, as far as interpreting control charts is concerned, note the illustration in figure 17.15 in your prescribed book, which shows six different scenarios and the action which can be taken in each case.
- (5) To summarise: Statistical process control (SPC) is about checking whether the process for the manufacture of a product or delivery of a service is either in control (ie variations are within the limits of the natural process variation owing to common causes), in which case the process may continue, or outside control. Outside control is when variations are outside the limits of the natural process variation owing to one or more assignable causes, in which case the process must be stopped, investigated and the causes of the unnatural variation must be eliminated or removed.

ANNEXURE 3

Statistical Process Control

Example 1

ABC Pharmaceuticals manufacture needles that are subjected to a bend test. They use **statistical process control (SPC)** and the results (measured in grams) are plotted on a chart.

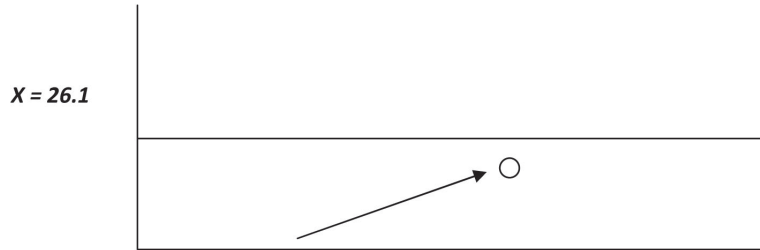
- If the process average is 26,1 and the average range is 5, what will the control limits be if the sample size $n = 8$? The factor for calculation of control limits is 0,373 for sample size $n=8$.

- Draw a chart and explain whether an investigation for an assignable cause should be undertaken given that one sample average is 26,08?

Solution

$UCL = \text{Control limits are: } X + A_2R = 26.1 + .0373 \times 5 = \mathbf{27.965}$

$LCL = \text{Control limits are: } X - A_2R = 26.1 - .0373 \times 5 = \mathbf{24.235}$



Sample average – process in control, no need for investigation

Example 2

A production process at **FLOWLINE INC** is being monitored for quality assurance purposes. Thirty (30) samples with a sample size of 8 have been taken and have yielded an overall mean of 28.5 and an average range of 1.6. The constant values for the sample size are as follows:

n	A	A ₂	A ₃	c ₄	d ₂	D ₁	D ₂	D ₃	D ₄
8	1.061	0.373	1.099	0.9650	2.847	0.388	5.306	0.136	1.864

Asked:

- Construct** an R — and an x bar chart.
- At a later stage, 6 samples produce the following sample means: 28.001, 28.250, 29.130, 28.720, 28.900, and 28.300. **Motivate** – is the process **in control**?
- Does the following sequence of sample means indicate that the process is **out of control**: 28.300. 28.700. 28.100, 28.900, 28.010, 29.010? **Justify** your answer.

Solution

Evans & Collier (2007:20, 701)

- Insert control charts:**
 $x \text{ bar chart UCL } 28.5 + 0.373(1.6) = 29.097$
 $LCL 28.5 - 0.373(1.6) = 27.903;$
 $R \text{ chart UCL} = D_4 1.864(1.6) = 2.982$
 $LCL = D_3 0.136(1.6) = 0.218$
- Sample means of 29.13 above UCL – process out-of-control.
- All points within control limits and no shifts or trends seem present.

Example 3

Four samples of three observations each have been taken, with actual measurements (in centimetres) shown below. Construct three sigma mean and range charts, and determine if corrective action is needed. Refer to rhw table below for the applicable factors.

Sample			
1	2	3	4
12.3	11.9	12.0	12.1
12.2	12.2	12.2	11.8
12.1	12.2	11.8	11.8

Table 1

Number of Observations in Subgroup N	Factor for \bar{X} Chart A2	FACTORS FOR R CHARTS	
		Lower Control Limit D3	Upper Control Limit D4
2	1.88	0	3.27
3	1.02	0	2.57
4	0.73	0	2.28
5	0.58	0	2.11
6	0.48	0	2.00
7	0.42	0.08	1.92
8	0.37	0.14	1.86
9	0.34	0.18	1.82
10	0.31	0.22	1.78
11	0.29	0.26	1.74
12	0.27	0.28	1.72
13	0.25	0.31	1.69
14	0.24	0.33	1.67
15	0.22	0.35	1.65
16	0.21	0.36	1.64
17	0.20	0.38	1.62
18	0.19	0.39	1.61
19	0.19	0.40	1.60
20	0.18	0.41	1.59

Solution

MEAN AND RANGE CHARTS (ROUNDED TO 1 DECIMAL)					
	Sample 1	Sample 2	Sample 3	Sample 4	Overall
Observation 1	12.3	11.9	12.0	12.1	
Observation 2	12.2	12.2	12.2	11.8	
Observation 3	12.1	12.2	11.8	11.8	
Mean	12.2	12.1	12.0	11.9	12.1
Range	0.20	0.30	0.40	0.30	0.30

<p>MEAN CALCULATIONS</p> $UCL = \bar{X} + A_2 \bar{R}$ $= 12.1 + (1.02)(0.30)$ $= 12.406$ $LCL = \bar{X} - A_2 \bar{R}$ $= 12.1 - (1.02)(0.30)$ $= 11.794$ <p><i>In control because all measures are within these limits</i></p>	<p>RANGE CALCULATIONS</p> $UCL = D_4 \bar{R}$ $= 2.57(0.30)$ $= 0.771$ $LCL = D_3 \bar{R}$ $= 0(0.30)$ $= 0$ <p><i>In control, because all points are within these limits</i></p>
--	---

10.3 PROCESS CONTROL, LEARNING AND KNOWLEDGE



ACTIVITY 10.2

Study the fourth section of chapter 17 entitled "Process control, learning and knowledge" in your prescribed book and then answer and/or complete the following:

- (1) Why is it said that the role of process control (and SPC in particular) has, in recent years, changed and what do these changes entail?
- (2) What does the six sigma quality approach involve? How would the progressive narrowing of process variation contribute to the drive to zero defect?
- (3) How could six sigma, as a broad improvement concept, be used as part of process control, learning and improvement (knowledge)?



FEEDBACK: ACTIVITY 10.2

- (1) Questions 1 and 2. These questions deal with the change in the role of process control and the six sigma approach. Review the discussion by the authors of your prescribed book in chapter 17. Specifically note the logic of the argument regarding the changed role of SPC from traditional operational, immediate and "hands-on" POM technique, to it now being connected to the operation's strategic capabilities as described by the authors of your prescribed book. Also study figure 17.16 for a view of six sigma process variation.

Note the narrowing process variation on the number of defects produced by the process in the drive towards zero defects. Finally, study the worked-out example of an insurance process check of insurance claims in chapter 17. Do you agree with the calculations of proportional defective yield, defects per unit, defects per opportunity and defects per million opportunities?

- (2) Question 3. This question deals with six sigma as a broad improvement approach. Review the discussion by the authors of your prescribed book in chapter 17. Also study table 17.7 in your prescribed book and note the other elements within the six sigma improvement concept which have been, or will be, discussed in your prescribed book.
-

10.4 ACCEPTANCE SAMPLING



ACTIVITY 10.3

Study the fifth section of chapter 17 entitled "Acceptance sampling" in your prescribed book and then answer and/or complete the following:

- (1) Process control is usually the preferred method of controlling quality because, but it is not always possible or practical. It may then be necessary to inspect whole batches of products or services either before or after a process. The purpose of acceptance sampling is therefore to
 - (2) Why is acceptance sampling usually carried out on attributes rather than variables? What are the inherent risks, in terms of type I and type II errors, associated with using acceptance sampling?
 - (3) How can sampling plans be used in acceptance sampling to decide whether to accept or reject a whole batch? What does an operating characteristic (OC) curve for a particular sampling plan entail?
 - (4) What would an ideal operating characteristic (OC) curve look like if the probability of accepting a batch with more than 0,04% defectives was zero and the probability of accepting a batch with less than 0,04% was 1 or 100 per cent?
 - (5) How would type I and type II errors that could be due to a sampling procedure influence the operating characteristics curve of a sampling plan and what would happen if the risks were then considered too great?
 - (6) Which four factors should be decided on when creating an appropriate acceptance sampling? What would an operating characteristic curve which shows these four factors look like?
 - (7) Type I error in acceptance sampling is referred to as the producer's risk because and type II error as the consumer's risk because
 - (8) What are the criticisms of acceptance sampling and how do some new approaches to quality control deal with these issues?
-



FEEDBACK: ACTIVITY 10.3

- (1) Questions 1 to 4. These questions deal with acceptance sampling, sampling plans and operating characteristics (OC) curves. Review the discussion by the authors of your prescribed book in chapter 17. Study table 17.8 in your prescribed book and note the decision to either reject or accept a batch, given that the batch is actually OK or not OK in combination with the occurrence of type I and type II errors. Also study figure 17.17 in your prescribed book, which illustrates the result of a sampling plan for acceptance

sampling as described by the operating characteristic (OC) curve for both the ideal and a real operating characteristic.

- (2) Questions 5 to 8. These questions deal with creating an appropriate acceptance sampling plan, taking into consideration type I and type II errors, acceptable quality level (AQL), lot tolerance percentage defective (LPTD) and the criticisms levelled against acceptance sampling. Review the discussion by the authors of your prescribed book in chapter 17. Then study figure 17.17, which illustrates the operating characteristic (OC) curve that shows the acceptable quality level (AQL) and lot tolerance percentage defective (LPTD), including the producer's and consumer's risk cut-off points. Finally, study the criticism of acceptance sampling by the authors of your prescribed book.
- (3) To summarise: Note that, while acceptance sampling is not regarded as the ideal method of controlling quality in processes (ie process control is viewed as a better method because quality is built in rather than "inspected in"), practical considerations sometimes make it necessary to use this method to inspect whole batches of products or services (either before or after the completion of a production and operations process). That a certain number of defects or failures will inevitably occur at the beginning of a process may cause an organisation to emphasise eliminating poor quality products and services rather than directing all its efforts to continuously improving quality. Do you agree?



CHECK LIST

Now that you have completed study unit 10 on statistical process control (SPC) and acceptance sampling (AS) in operations, you should be able to do the following:

- Describe what statistical process control (SPC) involves and explain how it may be used to monitor the variation in process quality.
- Draw up control charts for attributes and variables.
- Describe how the role of process control has changed with learning and process knowledge.
- Explain the use and workings of the six sigma quality approach.
- Describe what acceptance sampling (AS) entails and explain how it can be used to draw up an acceptance sampling plan.
- Use your knowledge of, and insight into
 - (1) statistical process control (SPC) used to monitor the variation in process quality and draw up control charts for attributes and variables
 - (2) the changed role of process control with learning and process knowledge and using the six sigma quality approach
 - (3) acceptance sampling (AS) as used to draw up an acceptance sampling plan

to justify their importance and to demonstrate that you understand this by being able to answer either multiple-choice or essay-type questions based on the study material. You should also be able to do practical applications.

- Demonstrate that you appreciate the need for statistical process control (SPC) and acceptance sampling (AS) production and operations management by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.
-



SUMMARY

This study unit examined statistical process control (SPC) and acceptance sampling (AS). In conjunction with the previous study unit, which focused on ensuring quality in production and operations management systems, it formed part of topic 6, which examined quality planning and control. SPC and AS are thus methods of quality control that can be used in step 4 of the quality planning and control activity. Preceding this step, however, are steps 1, 2 and 3 which involve defining the quality characteristics, deciding on how to measure them and setting standards for acceptable or unacceptable performance.



ASSESSMENT

Complete study activities 3 and 4 at the end of chapter 17 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, others may even send you on a trip to a local business/organisation to investigate an aspect of the subject for yourself.

TOPIC 7

PROJECT MANAGEMENT

AIM

To provide you with an understanding of what project planning and control and network analysis involve and why all are important for production and operations management.



LEARNING OUTCOMES

Once you have worked through this topic, you should be able to do the following:

- Describe what a project involves.
- Explain how to go about successful project management.
- Describe what is involved in each of the stages of the project planning and control process.
- Explain how they can contribute to successful project management.
- Describe what is entailed in network analysis and explain how the techniques available can help project managers deal with project complexity.
- Describe what computer-assisted project management entails and explain the elements of Enterprise Project Management (EPM).
- Use your knowledge of, and insight into
 - projects
 - successful project management
 - each of the stages of the project planning and control process and how they contribute to successful project management
 - network analysis and the techniques available to help project managers deal with project complexity
 - computer-assisted project management and Enterprise Project Management (EPM)

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate your appreciation of project management by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.
-



TOPIC STUDY UNITS

- Study unit 11 Project planning and control
(chapter 16)
- Study unit 12 Network analysis
(chapter 16)
-

Study unit 11

PROJECT PLANNING AND CONTROL



KEY CONCEPTS

project	activities, relationships and dependencies
actual costs incurred	assessing project performance
actual cost of work performed (ACWP)	budgeted cost of work performed (BCWP)
budgeted cost of work scheduled (BCWS)	complexity of projects
control of project	cost variance (CV)
critical path (CP)	$CV = BCWP - ACWP$
dependent or series relationships	earned value control
elements of a project	hierarchy of project objectives
independent or parallel relationships	internal/external project changes
low-volume, high-variety operations	most likely estimate
optimistic estimate	pessimistic estimates
planned expenditure	probabilistic estimates
project control	project definition
project environment	geo-social environment
eco-political environment	business environment
internal environment	project management
project managers	project milestones
project monitoring	project objectives
project performance objectives	project phases
project plan	project planning and control process
project planning process	project specification
project scope	project stakeholders
project strategy	schedule constraints
projects versus programmes	successful project management
schedule variance (SV)	time and resources requirements
$SV = BCWP - BCWS$	uncertainty of projects
typology of projects	virtual project management
work breakdown structure (WBS)	
earned-value control	

GETTING AN OVERVIEW

This study unit covers the first three learning outcomes of topic 7. In this study unit, we shall discuss projects, successful project management, each of the stages of the project planning and control process and how they contribute to successful project management.

11.1 INTRODUCTION IN PRESCRIBED BOOK



READ

First read the introduction to chapter 16 in your prescribed book and note the basic composition of figure 16.1. This figure depicts a model of project planning and control activities in production/operations management. You need to memorise this figure, because it serves as a mind map for the remainder of the study unit. After you have done this, read the points listed under the question: “What is a project and what is project management?”, the points listed under the question: “Why is it important to understand the environment in which a project takes place?”, the point listed under the question: “How are specific projects defined?” and the points listed under the question: “What is project planning and why is it important?” in the summary answers to key questions at the end of chapter 16.

11.2 DEFINITION OF A PROJECT



ACTIVITY 11.1

Read the case study entitled “The Comrades Marathon” in chapter 16 of your prescribed book and then answer the following questions:

- (1) Why do the authors say that the Comrades Marathon is not just one project but several? What is the implication of this in terms of project planning?
 - (2) Given that the organisers have a whole year to plan ahead for the event, why is the project nevertheless considered complex?
-



FEEDBACK: ACTIVITY 11.1

- (1) *Question 1. Although the main event is the running of the marathon itself, there are many smaller interrelated “projects” (namely TV broadcasting and radio coverage, the route that must be laid out and barriers erected). It is also necessary to organise traffic arrangements and cooperate with local authorities. Marshalls need to be trained and in place on the day, first aid and ambulances need to be arranged, refreshments for the runners along the route need to be in place, runners’ kits must be transported, etc. All these arrangements may, in themselves, be complex. Furthermore, all these arrangements need to be coordinated and made to “come together” on the day. Project complexity increases as the number of separate activities, resources required and number of people involved increase. With all the separate but interrelated activities that need to be planned, the logistics for the event in terms of resources which must be procured and the number of people involved in the whole event (11 189 runners in 2008!) makes the Comrades Marathon a complex project.*
- (2) *Question 2. Even though planning for the event may start a year in advance (and the project team for the Comrades Marathon have years of experience), each year is different and many things can still go wrong. Think of all the problems covered in each of the nine basic project management processes as defined in the project management body of knowledge (Project Management Institute Standards Committee 1996:6–7 [updated 2004]) – also known as PMBOK – published by the Project Management Institute (PMI),*

which may come into play when organising an event such as the Comrades Marathon. The basic processes are the following:

- *Project integration management. This involves ensuring that the various elements of the project, namely, the project plan development, project plan execution and overall change control, are properly coordinated.*
- *Scope management. This involves ensuring that the project covers all the work required to complete the project successfully which, in turn, consists of initiation, scope planning, scope definition, scope verification and scope change control.*
- *Time management. This involves ensuring that the project is completed on time and this, in turn, consists of activity definition, activity sequencing, estimating the duration of activity, schedule development and schedule control.*
- *Cost management. This involves ensuring that the project is completed within the approved budget, and consists of resource planning, cost estimating, cost budgeting and cost control.*
- *Quality management. This involves ensuring that the project will meet its objectives, and consists of quality planning, quality assurance and quality control.*
- *Human resource management. This involves ensuring that the most effective use is made of the people involved in the project, and consists of organisational planning, staff acquisition and team development.*
- *Communications management. This involves ensuring timely and appropriate generation, collection, dissemination, storage and ultimate disposition of project information. In other words, communications planning, information distribution, performance reporting and administrative closure.*
- *Risk management. This involves identifying, analysing and responding to project risk factors, and consists of risk identification, risk quantification, risk response development and risk response control.*
- *Procurement management. This involves acquiring goods and services from outside the performing organisation and consists of procurement planning, solicitation planning, solicitation, source selection, contract administration and contact closeout.*



ACTIVITY 11.2

Study the first section of chapter 16 entitled “What is a project?” in your prescribed book and then answer and/or complete the following:

- (1) A project is defined as
- (2) What are the special characteristics of projects that involve large-scale activities?
- (3) Some typically small- and large-scale, well-known projects which one sees regularly are
- (4) What are the common elements of projects and how do they determine the nature of a project and its planning and control?
- (5) What distinctions does your prescribed book draw between project planning and control versus project management, and projects versus programmes?
- (6) With what type of operations are projects normally associated and how can high-volume, continuous or mass-production operations also benefit from the generic principle of project planning and control?
- (7) Project planning and control are important for all managers because
- (8) A typology of projects may be constructed according to their level of complexity. This involves and their level of uncertainty, which involves
My own six examples based on complexity ranging from an individual to a multi-national project undertaking are

- (9) What value may be gained from viewing a typology of projects in the way suggested in your prescribed book and how can the elements of uncertainty and complexity influence the project planning and control activity?
 - (10) How can project planners deal with projects of high uncertainty and what are the dangers of projects which have many separate, but very interdependent activities?
-



FEEDBACK: ACTIVITY 11.2

- (1) *Question 1. Note that the Project Management Institute Standards Committee (1996:4) defines a project as "a temporary endeavour undertaken to create a unique product or service. Temporary means that every project has a definite beginning and end. Unique means that the product or service is different in some distinguishing way from all similar products and services". Note the emphasis placed on the two words "temporary" and "unique" as they have been defined above. A project is considered to be a human endeavour that has a beginning and an end and that has something that distinguishes it from something that has been done before.*
 - (2) *Questions 2 to 10. These questions deal with the definition of a project, their common elements and a typology of projects. Review the discussion by the authors of your prescribed book in chapter 16. Specifically note figure 16.2, where a typology of different projects is indicated, based on the degree of uncertainty and degree of complexity in a project. (By "degree of uncertainty", we mean the difficulty in predicting the final outcome in terms of time, cost and technical performance. By "degree of complexity", we mean the magnitude of effort, number of groups and organisations that need to be coordinated, and the diversity of skills or expertise needed to accomplish the work.) Note the "laws of project management" in your prescribed book and note the different effects that uncertainty and complexity have on various areas of project planning and control.*
-

11.3 ACHIEVING SUCCESSFUL PROJECT MANAGEMENT



ACTIVITY 11.3

Study the second section of chapter 16 entitled "Successful project management" in your prescribed book and then answer and/or complete the following:

- (1) In which important ways is it possible to minimise the chances of a project failing to meet its objectives? How can one work at reinforcing or focusing on these ways in order to improve the chances of the project succeeding?
 - (2) All projects need a project manager. The role of project managers is to and they do this by
 - (3) What tasks must a project manager undertake to manage a project successfully?
 - (4) What are the five important characteristics of an effective project manager and how can a basic knowledge of production and operations management help to develop and support these characteristics?
-



FEEDBACK: ACTIVITY 11.3

- (1) *Question 1. Note that the Project Management Institute Standards Committee (1996:6) defines project management as "the application of knowledge, skills, tools and techniques*

to project activities in order to meet or exceed stakeholder needs and expectations from a project". The success of project management depends on the project objectives, which usually involve the three dimensions of time, cost and performance and being satisfied. It also involves the agreement on the part of all stakeholders, both internal and external to the project environment, that their expectations have been met or exceeded and they understand the value of the project.

- (2) Questions 2 to 4. These questions deal with minimising the chances of project failure, and the tasks and characteristics of an effective project manager. Review the discussion by the authors of your prescribed book in chapter 16. Competent project managers are vital for project success – they are a unique species (in some cases earning more than the CEO). Interestingly enough, at least three of the characteristics that are regarded as important for an effective project manager clearly require "time" to cultivate or cannot easily be taught. By which we mean a background in, and experience of, such projects, strategic expertise of the overall project and environment, and proven managerial ability based on a track record. Maybe that is why successful project managers usually need a bit of "grey hair"!

11.4 STAGES OF THE PROJECT PLANNING AND CONTROL PROCESS



ACTIVITY 11.4

Study the third section of chapter 16 entitled "The project planning and control processes" in your prescribed book and then answer and/or complete the following:

- (1) What does each of the project stages as identified in the project management model and illustrated in figure 16.3 of your prescribed book involve? According to this model, how should the problems and/or changes that occur during the project be dealt with?
- (2) Stage 1 of the project management model, termed "understanding the project environment" involves and is important because the environment influences the way the project is executed, for example The environment as such is the main determinant of any inherent uncertainty in the project, for example
- (3) Who are the project stakeholders and why should they be involved in the project from the start?
- (4) Stage 2 of the project management model, termed "project definition", involves determining the elements of the project objectives which provide, the project scope, which identifies and the project strategy, which defines Each is important because
- (5) What is the importance of a "hierarchy of project objectives" for a particular project? How should project objectives be expressed in order to assess whether or not they have been achieved?
- (6) What are the performance objectives of project management and how do they differ and/or concur with the performance objectives of production and operations management?
- (7) Why and how can trade-offs between the performance objectives of project management be made?
- (8) What issues should be included or covered in the definition of the scope of a project and how are these issues formalised in the project specification?

- (9) Why is it possible for many changes to occur during the course of the project and how should internally and externally driven changes be dealt with?
- (10) Stage 3 of the project management model, termed “project planning”, is a process of five steps. The first of these steps is to identify activities which involve, the second, to estimate times and resources which involve, the third, to identify relationships and dependencies which involve, the fourth, to identify schedule constraints which involve and the fifth, to fix the schedule which involves
- (11) What purpose does project planning fulfil and why is replanning not necessarily seen or regarded as project failure?
- (12) What does a work breakdown structure (WBS) entail and what would such a structure look like in the case of, say, a project to install a water sprinkler system in a garden?
- (13) What are the different classes of estimates and why do they become more accurate as the project moves towards completion?
- (14) Probabilistic estimates are used where and, in practice, could be based on a positively skewed distribution with an optimistic estimate, that is, a probable estimate, which means and a pessimistic estimate, which means
- (15) While all project activities are related to one another, some are characterised by a dependent or series relationship which means and others by an independent or parallel relationship, which means My own example of each type is as follows:
- (16) What are the two fundamental approaches to matching the project requirements with the available resources? How would resource-loading problems of, say, too few or too many resources be dealt with?
- (17) Why should project planners ideally have a number of alternatives available to consider as far as schedule constraints are concerned?
- (18) Stage 4 of the project management model, termed “technical execution” involves, and my own practical example is
- (19) Stage 5 of the project management model, termed “project control”, takes place the execution of the project and comprises three sets of decisions in terms of: (a) project monitoring, which involves, (b) assessing project performance, which involves, and (c) intervening when changes are necessary, which involves
- (20) How are projects usually monitored? What typical measures should be monitored to determine how well the project is performing in terms of the project performance objectives of time, cost and quality?
- (21) How can project management assess the performance of a project in terms of its performance objectives of quality, cost and time at any point during the project?
- (22) Why does the total cost curve for an entire project resemble an S shape and how can such a curve be used to assess the project’s performance in terms of planned expenditure and actual costs incurred?
- (23) What does the earned-value method of project control entail? How can this be used in a practical manner to determine the budgeted cost of work scheduled (BCWS), the budgeted cost of work performed (BCWP), the actual cost of work performed (ACWP), the cost variance (CV) and schedule variance (SV) of a project?
- (24) How should project managers decide when to intervene and change the current course of a project? Why do some projects need some form of intervention even if they are proceeding according to plan and are within their schedule and cost variance tolerance limits?



FEEDBACK: ACTIVITY 11.4

- (1) Question 1. Note that the five project planning and control stages all have a vital role to play in the success of project management. While the first three stages and also, to some extent, the fourth, all deal primarily with the initial planning considerations of the project, the last stage, project control, activates feedback loops for replanning of, and/or changes in, the project planning process. The iterative nature of the process allows the project's performance objectives to be achieved and the project to be completed to the satisfaction of all stakeholders. Also study figure 16.3 in your prescribed book and note the sequential nature of the stages of the project management model leading to stage 5 (project control), which provides feedback or change/corrective action loops.
- (2) Questions 2 and 3. These questions deal with stage 1, that is, understanding the project environment and project stakeholders. Review the discussion by the authors of your prescribed book in chapter 16. Also note the diagrammatic illustration of the stakeholder power-interest grid in figure 16.4 of your prescribed book. Finally, read the case study of "The FIFA World Cup 2010" in chapter 16 of your prescribed book and answer the questions asked at the end of the case study.
- (3) Questions 4 to 9. These deal with stage 2, that is, project definition and various aspects of project objectives, project scope and project strategy. Review the discussion by the authors of your prescribed book in chapter 16. Also note the diagrammatic illustration of the project objectives triangle of time, cost and quality (performance) in figure 16.5 of your prescribed book. Finally, read the case study of "Diepkloof Xtreme Park Makeover" in chapter 16 of your prescribed book and answer the questions asked at the end of the case study.
- (4) Questions 10 to 17. These questions deal with stage 3, that is, project planning and the various stages of the project planning process. Review the discussion by the authors of your prescribed book in chapter 16. Note the diagrammatic illustration of the project planning process itself in figure 16.6 and the example of a work breakdown structure (WBS) in figure 16.7 of your prescribed book. Study the example in chapter 16 of your prescribed book of the time and resource estimates for a "breakfast-in-bed" project (see table 16.2 in your prescribed book) and consider the probability distribution of time estimates as illustrated in figure 16.8 of your prescribed book. These range from an optimistic time estimate (everything went well) to a pessimistic estimate (almost everything goes wrong) and the most likely estimate (which has the highest probability of being correct). Also study the critical remarks made by the authors of your prescribed book about the "guessing" nature of time estimates in chapter 16 of your prescribed book. Do you agree with them? Finally, study both figures 16.9 and 16.10, which illustrate a project plan for a simple project with resources; first if all activities are done at the same time and secondly if the activities are staggered and done after each other. Note that, in both cases, the project duration is nine minutes but, in the first case, four people are initially required to do the job, while in the second case only one person is required to do the job. The example can be taken even further by preparing a so-called "optimised" plan, whereby the toast is made at the same time the egg is boiled in order to ensure "warm toast" with the breakfast – see figure 16.11 in your prescribed book. Note that the total time duration is still nine minutes, but this added "luxury" of warm toast with the breakfast was obtained by merely rearranging the sequence of activities.
- (5) Question 18. This question deals with stage 4, that is, technical execution. Note that the authors of your prescribed book in chapter 16 have not said much about this issue, since this issue is determined by the specific technicalities or technical specifications of an individual project.
- (6) Questions 19 to 24. These deal with stage 5, that is, project control planning, including the decisions related to project monitoring, assessing project performance and project change intervention. Review the discussion by the authors of your prescribed book in chapter 16. Study the diagrammatic illustration of the comparison of planned and actual

expenditure in figure 16.12 of your prescribed book and note the S shape of the planned expenditure curve. Also study the diagrammatic illustration of the method of earned-value control in figure 16.13 of your prescribed book. This method uses the planned and actual value of the work completed to calculate both cost and schedule variances. Finally, read the case study of "Virtual project management" and answer the questions asked at the end of the case study.

- (7) To summarise: Note that the five project planning and control stages all have a vital role to play in the success of project management. While the first three stages and also, to some extent, the fourth, all deal primarily with the initial planning considerations of the project, the last stage, project control, activates feedback loops for replanning of, and/or changes in, the project planning process. The interactive nature of the process allows the project's performance objectives to be achieved and the project to be completed to the satisfaction of all stakeholders.



CHECK LIST

Now that you have completed study unit 11 on project planning and control, you should be able to do the following:

- Describe what a project entails.
- Explain how to achieve successful project management.
- Describe what each of the stages of the project planning and control process involves and explain how each stage contributes to successful project management.
- Use your knowledge of, and insight into
 - projects
 - successful project management
 - each of the stages of the project planning and control process and their contribution to successful project management

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer either multiple-choice or essay-type questions.

- Demonstrate that you appreciate the need for project planning and control by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



SUMMARY

This study unit examined project planning and control in operations. Once we had established an understanding of what a project entailed, it was possible to consider what constitutes successful project management. Successful project management can be achieved by paying attention to and performing tasks involved in each of the stages of the project planning and control process. The next study unit, study unit 12, will focus specifically on some of the techniques and methods available to help project managers improve the project planning and control process.



ASSESSMENT

- (1) Read the case study entitled “PPP projects and the Gautrain” at the end of chapter 16 in your prescribed book and answer the questions asked at the end of the case study.
- (2) Complete study activities 1, 2 and 4 at the end of chapter 16 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, others may even require you to visit a local business/organisation to investigate an aspect of the subject for yourself.

SOURCE REFERENCES

Project Management Institute Standards Committee. 1996. *PMBOK Guide: a guide to the project management body of knowledge*. Upper Darby, Pa: PMI.

Study unit 12

NETWORK ANALYSIS



KEY CONCEPTS

activities in parallel	activities in series
activity duration	activity on node networks
activity on arrow (AoA) method	activity on node (AoN) method
activity reference	backward pass
crashing networks	critical path (CP)
critical path method (CPM)	deterministic (fixed) times
dummy activity	duration
earliest finish times (EF)	earliest start times (ES)
event	expected time (te)
forward pass	Gantt chart
latest finish time (LF)	latest start time (LS)
longest sequence of activities	network planning or analysis
paths	probabilistic (estimate) times
programme evaluation and review	resource schedule
technique (PERT)	te formula
time analysis	tl = most likely time
to = optimistic time	tp = pessimistic time
total float	V formula
variance of distribution (V)	computer-assisted project
enterprise project management (EPM)	management

GETTING AN OVERVIEW

This study unit covers the fourth and fifth learning outcomes of topic 7. In this study unit, we shall discuss network analysis and the techniques available to help project managers deal with project complexity – these techniques include computer-assisted project management.

12.1 INTRODUCTION IN PRESCRIBED BOOK



READ

Again, read the introduction to chapter 16 in your prescribed book and note the basic composition of figure 16.1. This figure depicts a model of project planning and control activities in production/operations management. You need to memorise this figure, because it serves as a mind map for the remainder of the study unit. After you have done this, read the points listed under the question: “What techniques can be used for project

planning?”, and the points listed under the question: “What is project control and how is it done?” in the summary answers to key questions at the end of chapter 16.

12.2 NETWORK ANALYSIS



ACTIVITY 12.1

Study the fourth section of chapter 16 entitled “Network planning” in your prescribed book and then answer and/or complete the following:

- (1) Two network analysis methods widely used are CPM, which stands for and PERT, which stands for These methods can help project managers a great deal in the planning and controlling of projects (which by their very nature are time based), especially very complex projects.
- (2) How can Gantt charts be used to plan and control a project and what are the advantages and disadvantages of this technique?
- (3) How can an arrow diagram be used to show the logic of relationships between activities? What would such an arrow diagram look like for a simple project (for example enlarging an existing kitchen)?
- (4) In an arrow diagram, the arrow represents an activity, which means and the circle an event, which means
- (5) What are the three basic rules for drawing a CPM network diagram and how can dummy activities be used diagrammatically to clarify relationships between activities?
- (6) Why, in network diagrams, where activities have parallel relationships, is there more than one sequence of activities (called “paths”) leading from start to finish of the project? What is the special significance of the critical path in a network diagram such as CPM?
- (7) Two methods for drawing a CPM network diagram are AoA (activity on arrow), where the arrow represents and the circles at the junctions or nodes of the arrows; the and AoN (activity on node) where the boxes represent and are used to define relationships. The method of representation used in an AoN network diagram is most frequently used because of the advantages of, and
- (8) What does the AoN convention in each activity box of a CPM network diagram involve and how are the earliest start (ES) times, earliest finish (EF) times, latest finish (LF) times and latest start (LS) times for each activity calculated or determined?
- (9) To perform a time analysis in a CPM network diagram, we start from left to right doing forward passes, which entail to calculate all the ES and EF times of all the activities. Then, once we have completed this, we move from right to left doing backward passes which entail to calculate the LF and LS times. Then we calculate each activity’s float, which is the difference between and Lastly, we identify the critical path (or paths) which joins the activities with
- (10) What is the basic difference in the point of departure of a PERT versus a CPM network diagram? How is the expected time (t_e) and the variance (V) of activities for all paths of a PERT network diagram calculated?
- (11) What is the advantage of calculating the expected times and variances of all the activities and paths of a network diagram? How would this information help a project

- manager to plan and control a project? Note: to calculate the standard deviation, take the square root of the variance.
- (12) What is the possible effect of resource restraints on a project? How can a resource schedule in combination with a network diagram be used to level the resource requirements?
 - (13) What does crashing a network involve and how would a project manager decide which activities to crash?
-



FEEDBACK: ACTIVITY 12.1

- (1) Question 1. Note that network analysis involves the use of techniques such as a Gantt chart, and CPM and PERT network diagrams to improve project planning and control. Some of the calculations for the time analysis may seem a bit complicated and some students may be inclined to argue that, in any case, a computer could do them. While that may be true, it is important to understand the logic behind the calculations if one is to use the techniques with any confidence.
 - (2) Question 2. This question deals with Gantt charts. Review the discussion by the authors of your prescribed book in chapter 16 and specifically refer back to the section on “scheduling” and “Gantt charts” in chapter 10 of your prescribed book. Also revise figure 10.10.
 - (3) Questions 3 to 6. These questions deal with the critical path method (CPM). Review the discussion by the authors of your prescribed book in chapter 16. Note figure 16.14, which illustrates the activities, relationships and durations of an arrow diagram (also referred to activity-on-arrow or AOA networks) and figure 16.15, which illustrates a network diagram. Note also figure 16.17, which again illustrates the network diagram with earliest and latest event times for the example of “decorate apartment”. Also study figure 16.16 in your prescribed book for an explanation of when so-called “dummy” activities are necessary. Study the worked-out example of the road construction activities (table 16.3) in chapter 16 of your prescribed book. Do you agree with the network diagram for this project as illustrated in figure 16.18? Finally, note the critical remarks made by the authors of your prescribed book about the sometimes rather vague idea of the start and end time of activities. Do you agree with their remarks? How do you think this problem can be solved?
 - (4) Questions 7 to 9. The previous questions dealt with AOA networks and these questions deal with the activity on node (AON) networks. Review the discussion by the authors of your prescribed book in chapter 16. Note figure 16.19, which illustrates an activity on node network, for the example of “decorate apartment”. Also note figure 16.20, which illustrates the AOA convention used in a precedence network.
 - (5) Questions 10 and 11. These questions deal with programme evaluation and review techniques (PERT). Review the discussion by the authors of your prescribed book in chapter 16. Note the calculation of the probabilistic time estimates as illustrated in figure 16.21 and the occurrence where one path in the network may have the longest expected duration while the other may have the greater variance (see figure 16.22). What is the significance of the latter occurrence?
 - (6) Question 12. This question deals with the introduction of resource constraints. Review the discussion by the authors of your prescribed book in chapter 16. Note the illustration of the resource profile of a network, assuming that all activities start as soon as possible (figure 16.23) and the resource profile of a network where non-critical activities are delayed in order to fit in with the resource constraints (figure 16.24).
 - (7) Question 13. This question deals with “crashing” networks. Review the discussion by the authors of your prescribed book in chapter 16. Note the illustration of a network where activities are “crashed” to shorten the project duration (figure 16.25 in your prescribed book) at a progressively higher cost.
-

ANNEXURE 4

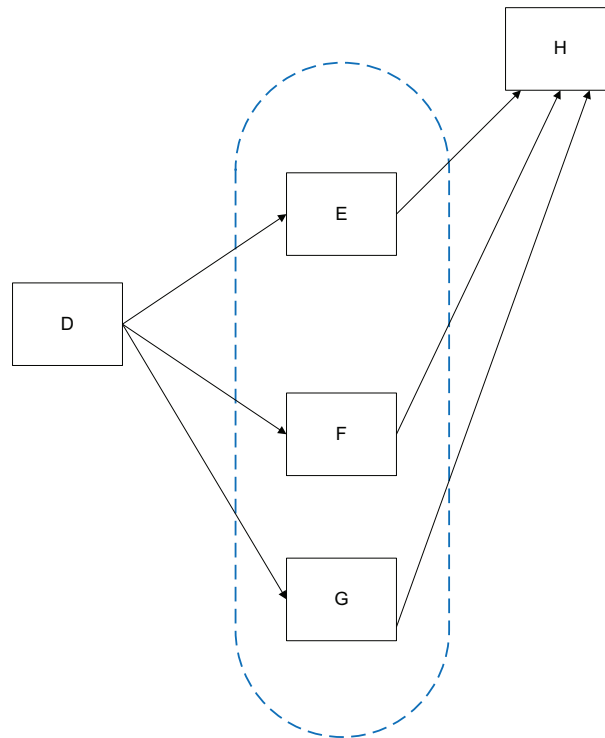
Network analysis

1. Introduction

The network diagram is about creating relationships between activities. Relationships are also referred to as dependencies – the most basic is “finish to start”. Thus the basic question is which activities must be finished before which activities can start. The use of an arrow (specifically in the notation used in this example) shows this relationship.



Activity A must be finished before B can start.



Activity E, F and G don't have to wait for each other. Note that E, F and G don't have to start and finish at the same time. They however need to be finished before H can start.

2. Basic rules for constructing the network diagram

- Networks typically flow from left to right;
- An activity cannot begin until all of its preceding activities are complete;
- Arrows indicate precedence and flow and can cross over each other;
- Identify each activity with a unique number; this number must be greater than its predecessors;
- Looping is not allowed;

- Conditional statements are not allowed;
- Use unique start and stop nodes.

3. Information recorded for each node

EST _{<i>i</i>}	EFT _{<i>i</i>}
<i>i</i>	<i>T_i</i>
LST _{<i>i</i>}	LFT _{<i>i</i>}

t_i = DURATION required to perform activity *i*

EST_{*i*} = earliest possible start for activity *i*

EFT_{*i*} = earliest possible finish for activity *i*

LST_{*i*} = latest possible start for activity *i*

LFT_{*i*} = latest possible finish for activity *i*

The following seven steps can be followed to construct the popular and most commonly used AON network:

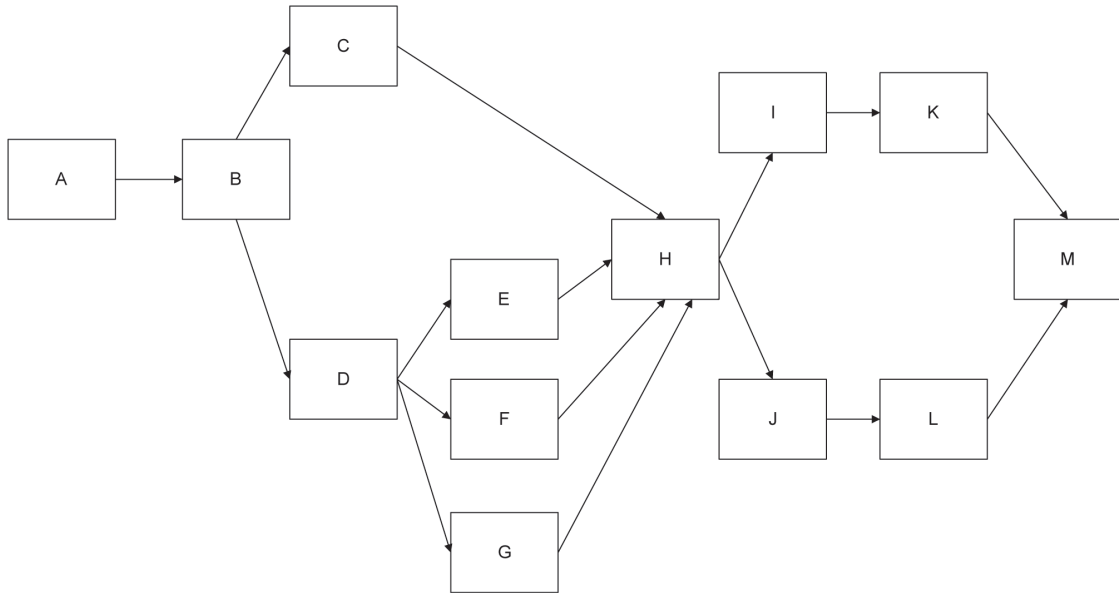
- (1) List all the activities/work packages of the subproject/project, with the time duration of each.
- (2) Indicate the followers or precedent activities of each activity.
- (3) Draw the network according to the sequence of activities by using lines between the nodes. The nodes (AON) represent the beginning and the completion of one entire activity.
- (4) Determine the critical path. This is the longest route through the network when all the possible routes are followed from the beginning to the end of the network. Add the time duration of each activity to calculate the critical path. This path is crucial since the entire project and its resource allocations will be based on it. The critical path may not be compromised, and penalties may be applicable if the project is extended beyond the project duration as indicated by the critical path. The ES and LS times and the EF and LF times of activities on the critical path are the same (because there is no slack on the critical path).
- (5) Slack may be available on activities which are not on the critical path. The way to calculate the slack is to work from left to right through the network by calculating the ES and EF times. If an activity has two or more predecessors, the activity with the largest EF will determine the ES of the follower activity, since the activity may not start unless all preceding activities are completed.
- (6) Work from right to left through the network in calculating the LF and LS times. If an activity has more than one follower, then the smallest follower LS will determine the LF of the preceding activity (working from right to left).
- (7) The difference between ES and LS is the total slack available at that activity before the total project will be delayed.

4. Example 1

Activity	Activity time (days)	Immediate predecessors(s)
A	3	-
B	4	A
C	3	B
D	10	B
E	8	D
F	4	D
G	6	D
H	8	C, E, F, G
I	5	H
J	5	H
K	4	I
L	2	J
M	4	K, L

Draw a CPM (critical path method) network based on the information given above.

Step 1: Draw the activity-on-node (AON) network (basic framework)



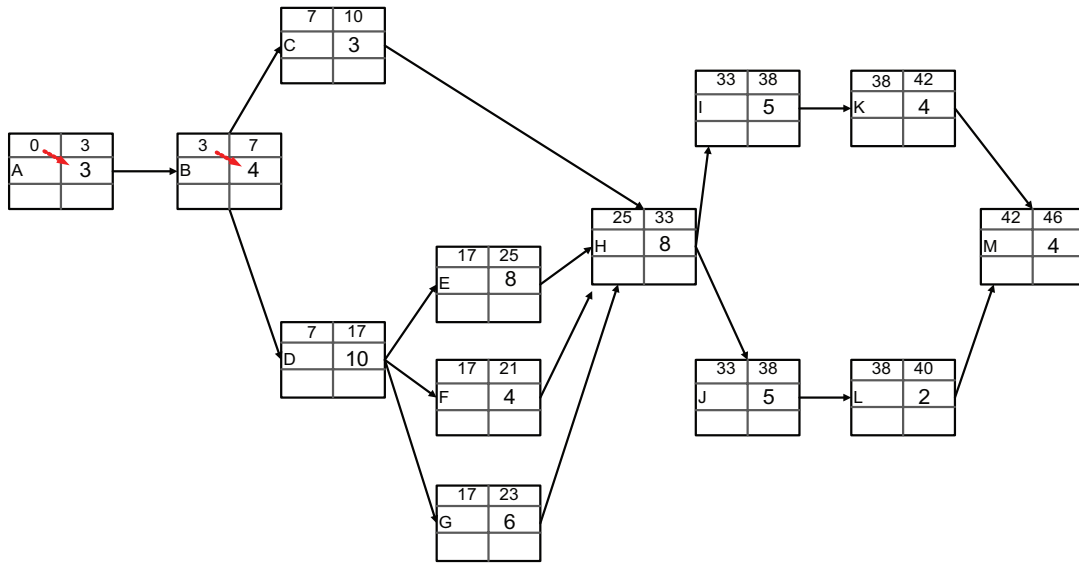
Step 2: Calculate the forward and the backward pass

- A *Forward pass* through the network determines the earliest times each activity can start and finish – ALSO DETERMINE THE TOTAL DURATION OF THE PROJECT.
- A *Backward pass* through the network determines the latest times each activity can start and finish without delaying completion of the project – WITH THIS INFORMATION WE CAN DETERMINE WHERE WE CAN DELAY ACTIVITIES (HAVE SLACK) AND WHERE WE CANNOT.

Forward pass

- The earliest start (EST) for the initial activity in a project is "time zero";
- The EST of an activity is equal to the latest (or maximum) early finish of the activities directly preceding it;
- The EFT of an activity is equal to its EST plus the duration required to perform the activity.

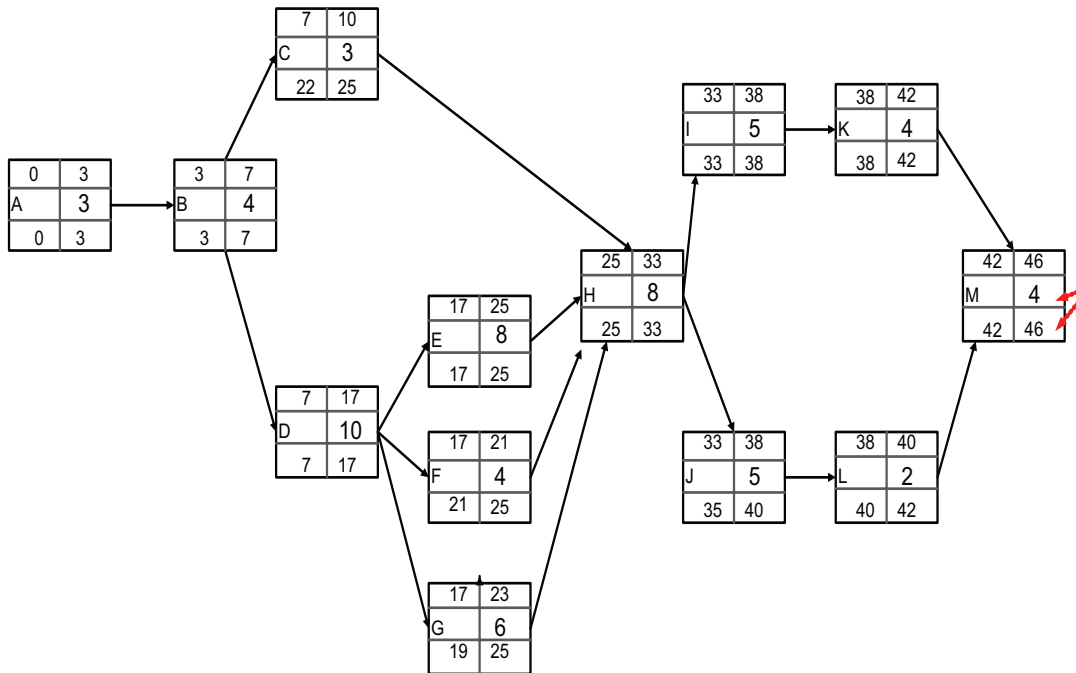
Results of the Forward Pass:



Backward Pass

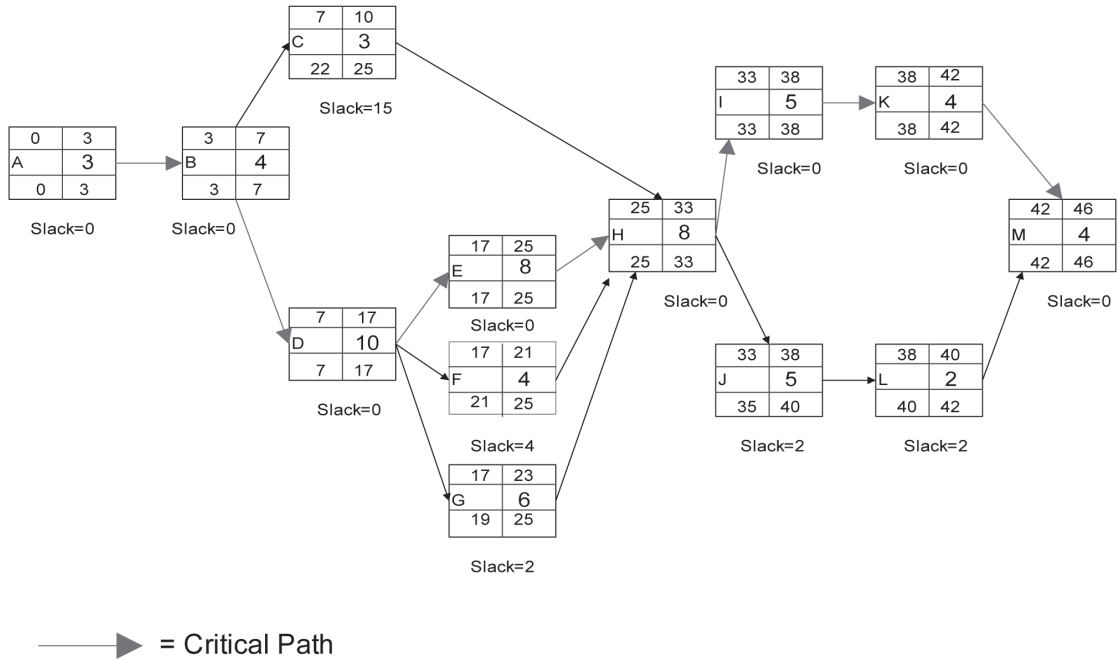
- The latest finish (LFT) for the final activity in a project is equal to its EFT as determined by the forward pass;
- The LFT for any other activity is equal to the earliest (or minimum) LST of the activities directly following (or succeeding) it;
- The LST of an activity is equal to its LFT minus the time required to perform the activity.

Results of the backward pass:



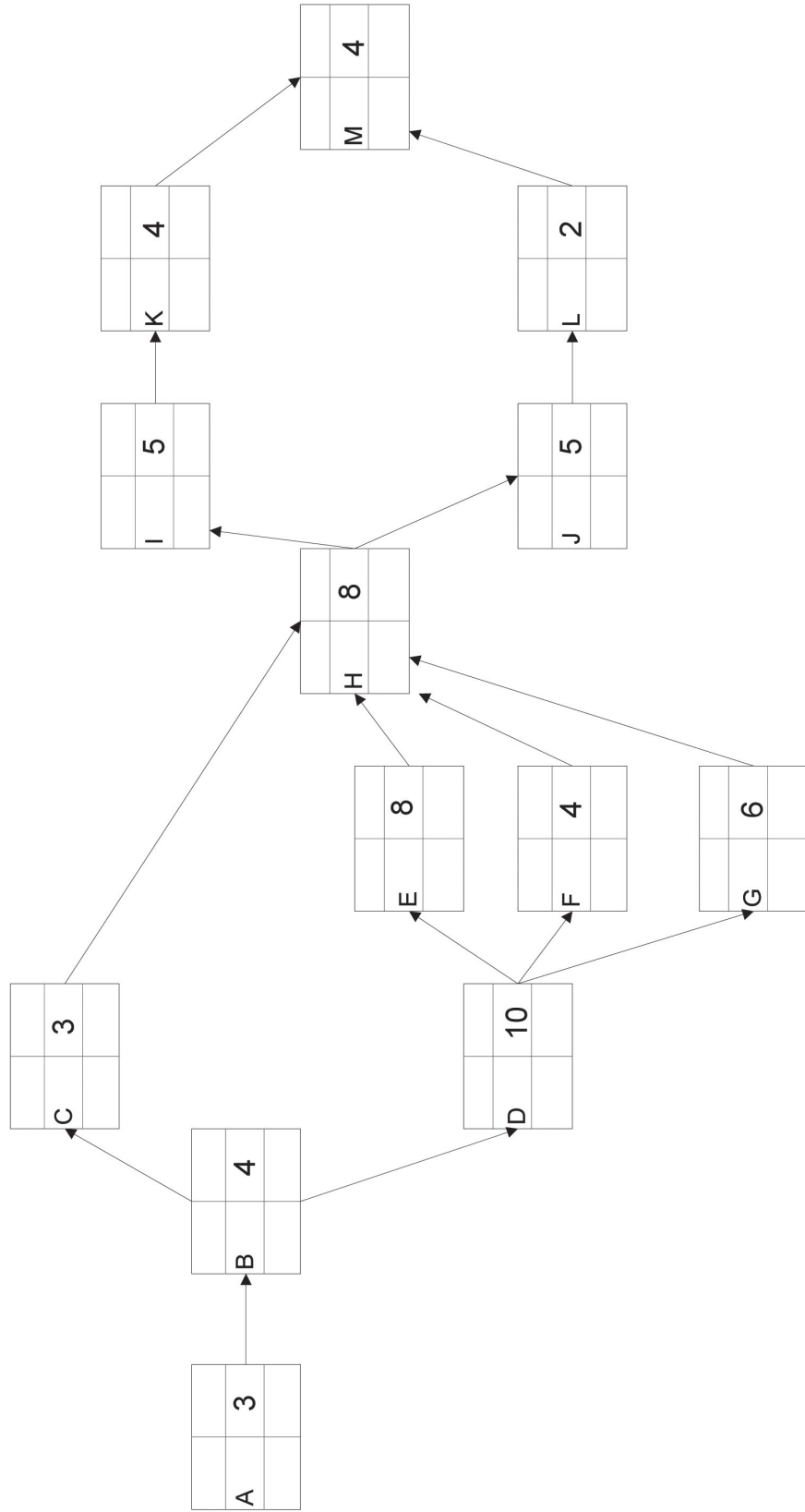
Step 3: Determining the critical path

- Critical activities have zero slack and cannot be delayed without delaying the completion of the project;
- The slack for non-critical activities represents the amount of time by which the start of these activities can be delayed without delaying the completion of the entire project (assuming that all predecessor activities start at their earliest start times);
- The longest path on the network;
- Could also be those activities with the least slack.



(Source: <http://www.slideshare.net/dmdk12/the-network-diagram-and-critical-path>)

Example 1 exercise sheet



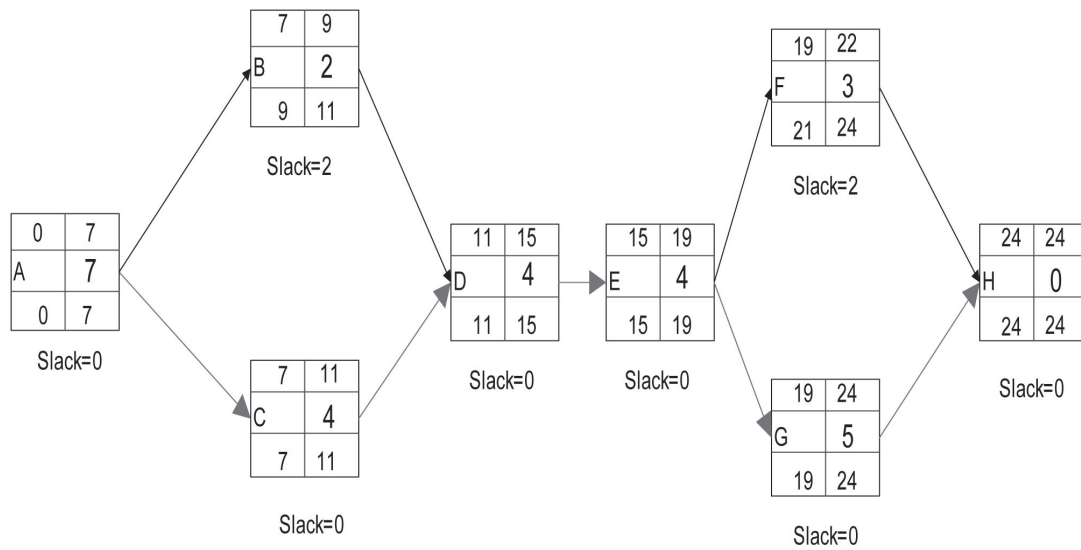
5. **Example 2**

Activity	Activity time (days)	Immediate followers
A	7	B, C
B	2	D
C	4	D
D	4	E
E	4	F, G
F	3	H
G	5	H
H	0	-

- (a) **Draw the network diagram for this project.**
- (b) **Determine the critical path and project duration.**
- (c) **Calculate the free slack for each activity.**

Solution

(a)

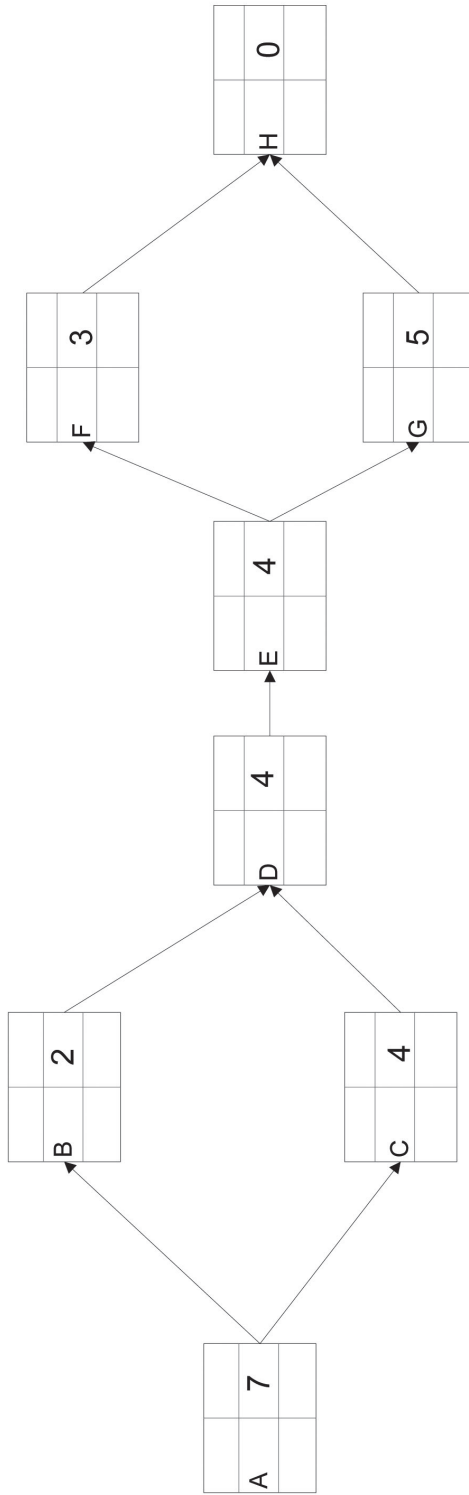


(b) The critical path is A–C–D–E–G–H with a completion time of 24 days.

Activity	Duration	Earliest	Latest	Earliest	Latest	Slack	On critical
		Start	Start	Finish	Finish		Path ?
A	7	0	0	7	7	0	Yes
B	2	7	9	9	11	2	No
C	4	7	7	11	15	0	Yes
D	4	11	11	15	15	0	Yes
E	4	15	15	19	19	0	Yes
F	3	19	21	22	24	2	No
G	5	19	19	24	24	0	Yes
H	0	24	24	24	24	0	Yes

(c) The free slacks for all activities in days are A (0); B (2); C (0); D (0); E (0); F (2); G (0) and H (0).

Example 2 exercise sheet



6. Example 3

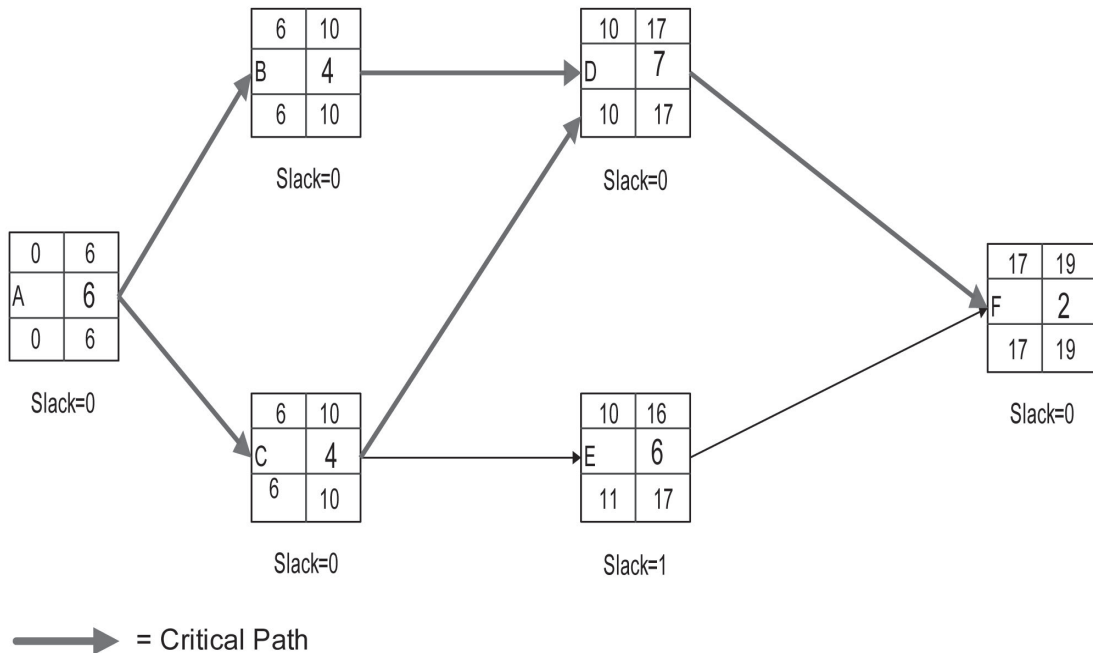
A tender has recently been won by **XR Projects** to construct a mini-substation. The project consists of the following six activities:

Activity	Immediate predecessor (s)	Normal duration
A	None	6 weeks
B	A	4 weeks
C	A	4 weeks
D	B, C	7 weeks
E	C	6 weeks
F	D, E	2 weeks

- (a) Draw a network diagram for the project. It is recommended that you use the AON format.
- (a) What is the earliest completion time for the project as a whole? Assume the LF value for the project is equal to the highest EF value.
- (a) What is the critical path and why is it significant?

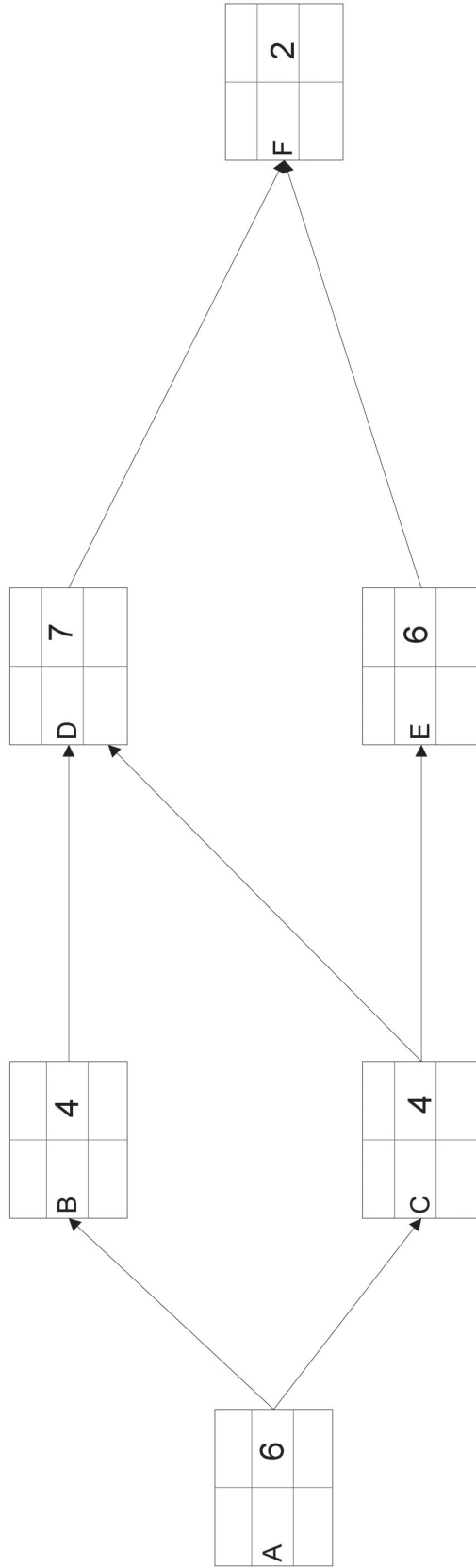
Solution

(a)



- (b) Day 19
- (c) Two critical paths. A B D F and A C D F. Only activity E has any slack (1 week)

Example 3 exercise sheet



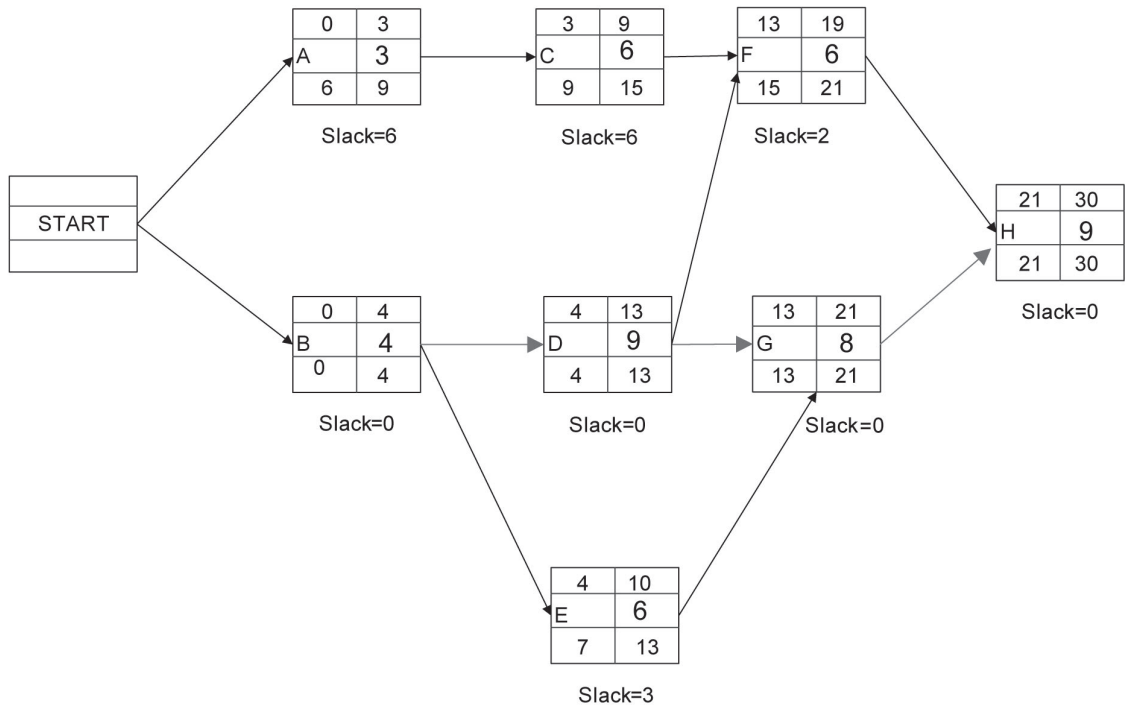
7. Example 4

Draw the network corresponding to the following information. Also, complete the table, identify the critical path, and specify project completion time.

Activity	Immediate Predecessors (s)	Time (weeks)
A	-	3
B	-	4
C	A	6
D	B	9
E	B	6
F	C, D	6
G	D, E	8
H	G, F	9

Activity	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack
A					
B					
C					
D					
E					
F					
G					
H					

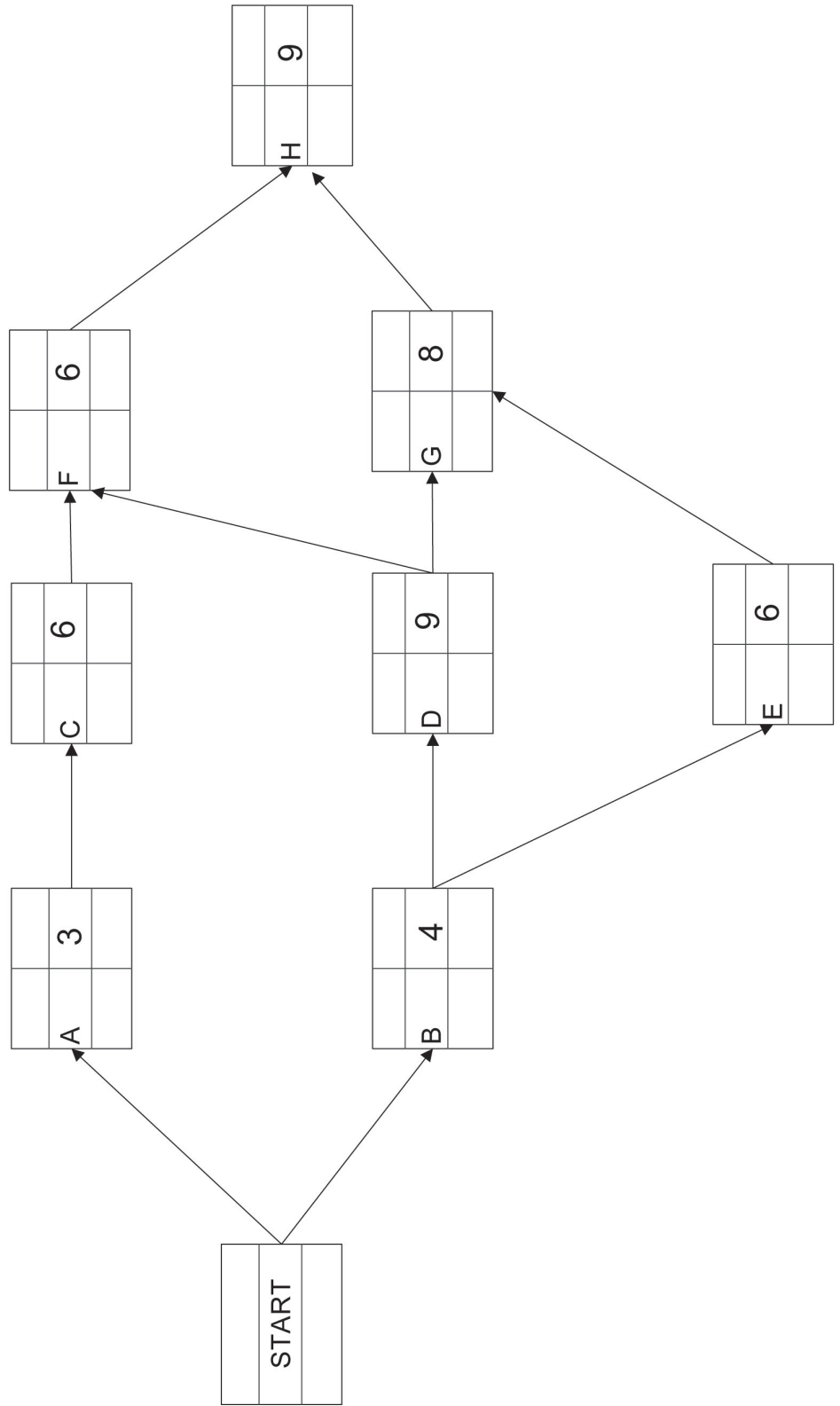
Solution



→ = Critical Path

Activity	Earliest Start	Earliest Finish	Latest Start	Latest Finish	Slack
A	0	3	6	9	6
B	0	4	0	4	0
C	3	9	9	15	6
D	4	13	4	13	0
E	4	10	7	13	3
F	13	19	15	21	2
G	13	21	13	21	0
H	21	30	21	30	0

Example 4 exercise sheet



12.3 COMPUTER-ASSISTED PROJECT MANAGEMENT



ACTIVITY 12.2

Study the fifth section of chapter 16 entitled “Computer-assisted project management” in your prescribed book and then answer and/or complete the following:

- (1) What are the advantages of computer-assisted project management?
 - (2) What are the elements of Enterprise Project Management (EPM) and how does it work?
-



FEEDBACK: ACTIVITY 12.2

- (1) *Question 1. This question deals with the advantages of computer-assisted project management. Review the discussion by the authors of your prescribed book in chapter 16. Note that these advantages for communication within large and complex projects paved the way for the development of Enterprise Project Management systems (EPM).*
 - (2) *Question 2. This question deals with Enterprise Project Management (EPM). Again, review the discussion by the authors of your prescribed book in chapter 16. Study the various elements of integrated EPM systems as illustrated in figure 16.26 of your prescribed book and note the advantages of integration in terms of communication capabilities.*
-



CHECK LIST

Now that you have completed study unit 12 on network analysis, you should be able to do the following:

- Describe what network analysis entails and explain how the techniques available can help project managers deal with project complexity.
- Describe what computer-assisted project management entails and explain the elements of Enterprise Project Management (EPM).
- Use your knowledge of, and insight into
 - network analysis and the techniques available to help project managers deal with project complexity
 - computer-assisted project management Enterprise Project management (EPM)

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you appreciate the need for network analysis by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.
-



SUMMARY

This study unit examined network analysis and computer-assisted project management in operations. In conjunction with study unit 11, it completes our discussion of project management. Project management is today widely recognised by both academics and

practitioners as a distinct management approach to projects, and a full module or more could be devoted to examining this specialist discipline on its own. However, we have confined our attention to just some of the aspects related to the planning and control of projects.



ASSESSMENT

- (1) Identify a small, simple project with, say, 10 activities with which you are familiar, and that would need 10 days to complete. Draw a Gantt chart and do time analysis exercises by using both the CPM and PERT methods. Introduce a resource constraint and crash the CPM network to a completion time of nine days.
-

PART III

IMPROVING THE PRODUCTION AND OPERATIONS MANAGEMENT SYSTEM FOR THE EMERGING CHALLENGES OF THE 21ST CENTURY

TOPIC 8

MEASURING PERFORMANCE AND IMPROVING THE PRODUCTION AND OPERATIONS MANAGEMENT SYSTEM

AIM

To provide you with an understanding of what is entailed in the measurement of performance and the improvement of the production and operations management system, and why this system is important for production and operations management.



LEARNING OUTCOMES

Once you have worked through this topic, you should be able to do the following:

- Explain what is entailed in measuring and improving the performance of the production and operations management system.
- Explain how production and operations managers decide where to start their improvement activities.
- Describe the various approaches to improvement which production and operations managers can use.
- Describe the improvement techniques that production and operations managers can use.
- Describe TQM as an approach to the management of improvement.
- Explain what the TQM approach entails.
- Explain how TQM improvement programmes can be implemented.
- Name the quality award schemes that currently exist and explain their purpose.
- Use your knowledge of, and insight into
 - measuring and improving the performance of the production and operations management system
 - where production and operations managers should start their improvement activities
 - the various approaches to improvement which production and operations managers can use
 - the improvement techniques that production and operations managers can use
 - TQM as an approach to the management of improvement
 - the TQM approach itself
 - the implementation of TQM improvement programmes
 - the quality award schemes that currently exist

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you appreciate the need to measure and improve the production and operations management system by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



TOPIC STUDY UNITS

- Study unit 13 Production and operations management improvement
(chapter 18)
- Study unit 14 Total quality management
(chapter 20)
-

Study unit 13

PRODUCTION AND OPERATIONS MANAGEMENT IMPROVEMENT



KEY CONCEPTS

absolute performance standards	acceptability boundary (AB)
approaches to improvement	appropriate zone
balance scorecard	benchmarking
better than/same as/worse	breakthrough improvement
business process re-engineering (BPR) approach	cause-effect diagrams
competitor performance	competitive benchmarking standards
composites of smaller measures	continuous improvement
excess zone	external benchmarking
fish-bone diagrams	flow charts
historical standards	importance for customers/clients
importance-performance matrix	improvement cycles
improve zone	improvement priorities
innovation-based improvement	input-output analysis
internal benchmarking	Ishikawa diagrams
kaizen	key performance indicators
less important/qualifying/order needs and preferences of competitors	lower bound of acceptability
order-winning	non-competitive benchmarking
PDCA cycle or Deming wheel	Pareto diagrams
performance benchmarking	performance against competitors
performance measurement	performance measures
performance standards	performance ratings
practice benchmarking	polar diagrams
sandcone theory	process maps
target performance standards	scatter diagrams
urgent-action zone	techniques of improvement
winning factor ratings	why-why analysis
DMAIC cycle (define, measure, analyse, improve, control)	zones of improvement priority
trade-off theory	continuous improvement (CI) capability
	see-saw trade-off paradigm

GETTING AN OVERVIEW

This study unit covers the first four learning outcomes of topic 8. We shall primarily discuss how to measure and improve the performance of the production and operations management system; deciding where production and operations managers should start their improvement activities; the various approaches to improvement that production

and operations managers can use; and the improvement techniques that production and operations managers can use.

13.1 INTRODUCTION IN PRESCRIBED BOOK



READ

First read the introduction to chapter 18 in your prescribed book and note the basic composition of figure 18.1. This depicts a model of improvement activities in production/operations management. You need to memorise this figure because it serves as a mind map for the remainder of the study unit. After you have done this, read the points listed under the question: “How can operations managers measure their performance in terms of the five performance objectives?”, the few points listed under the question: “How can operations managers prioritise improvement of performance objectives?”, the points listed under the question: “What are the broad approaches to managing the rate of improvement?”, the point listed under the question: “Where does business process re-engineering (BPR) fit into the improvement activity?” and the points listed under the question: “What techniques can be used for improvement?” in the summary answers to key questions at the end of chapter 18.

13.2 PERFORMANCE MEASUREMENT AND IMPROVEMENT



ACTIVITY 13.1

Read the case study entitled “Improvement at ABI – Africa’s largest bottler” in chapter 18 of your prescribed book and then answer the following questions:

- (1) How did the company set out to achieve its 20% improvement target for the plant’s operational equipment efficiency (OEE)?
 - (2) What was the impact of ABI’s performance improvement plan on its operations?
-



FEEDBACK: ACTIVITY 13.1

- (1) *Although the target may seem rather high, it was considered challenging yet achievable. The improvement project thus undertaken was set around two objectives: (a) to obtain accurate operational data that could be converted into useful business information on which improvement decisions could be based (this would ensure all functions had access to accurate and up-to-date information); and (b) changing the culture of the operation to encourage fast and effective decisionmaking (this encouraged staff to focus on how they could improve the way they did their job rather than just “doing the job”).*
 - (2) *Apart from significant cost savings, ABI achieved record-breaking line efficiencies thereby equalling world class standards in the beverage industry. Line efficiencies improved drastically and went up by 75% at all ABI sites, including an improvement of 45 to 65% at one site within 10 months. The improved efficiencies at all the South African sites have paved the way for ABI to become a world-class company and a leader in the bottling industry.*
-



ACTIVITY 13.2

Study the first section of chapter 18 entitled “Measuring and improving performance” in your prescribed book and then answer and/or complete the following:

- (1) Why is it necessary to start by measuring the current performance of the operation before launching any improvement initiatives?
 - (2) Performance measurement is the process of, where performance is defined as
 - (3) How can polar diagrams be used during performance measurement to evaluate whether the operation is performing well over time and meeting the needs and expectations of its markets?
 - (4) What is the relationship between a performance measure and a performance objective, and what are some typical performance measures for the following performance objectives: quality, speed, dependability, flexibility and cost?
 - (5) How are performance standards derived and what are the differences between historical performance, target performance, competitor performance and absolute performance standards?
 - (6) Benchmarking is an approach whereby, and its wider meaning is no longer restricted, confined, practised by, while the term “competitive” as in competitive benchmarking has also been widened to mean
 - (7) What are the types of benchmarking available to businesses and how do they fit in with the benchmarking objectives of internal, external, performance and activity comparisons?
-



FEEDBACK: ACTIVITY 13.2

- (1) *Questions 1 to 5. These questions deal with performance measurement and performance standards. Review the discussion by the authors of your prescribed book in chapter 18. Note figure 18.2, which illustrates two polar diagrams that represent the operations performance versus the customer/client’s needs and the change which may take place over time. Also study table 18.1 in your prescribed book, which illustrates the five performance objectives that we have been referring to throughout this module and some measures which can be used to gauge how the operation is performing in terms of one or more performance objectives.*
 - (2) *Questions 6 and 7. These questions deal with benchmarking. Review the discussion by the authors of your prescribed book in chapter 18. Study the critical remarks made by the authors of your prescribed book in chapter 18 concerning whether or not there is a fundamental flaw in the whole concept of benchmarking. Do you agree with them or does it all seem “a bit academic” to you?*
 - (3) *To summarise: Note that, in order to improve the performance of the production and operations management system of any business or enterprise, it is necessary to start by measuring its current performance, then set desired and/or required standards of performance, and finally to embark on an improvement programme or formulate and implement a plan of action to achieve such performance objectives. Furthermore, as emphasised in the introduction to this study unit, a business cannot improve the performance of its production and operations management system without first measuring its current performance. It does this by means of various performance measures and by setting itself certain performance standards to achieve in the future (by using processes such as competitive benchmarking).*
-

13.3 WHERE TO START THE IMPROVEMENT ACTIVITIES



ACTIVITY 13.3

Study the second section of chapter 18 entitled “Improvement priorities” in your prescribed book and then answer and/or complete the following:

- (1) Two major determinants of the way in which an operation decides which performance objectives it will emphasise are: (a) the needs and preferences of customers/clients, which shape; and (b) the performance and activities of competitors, which shape and have to be brought together before any decision can be made on the relative priorities for improvement because
 - (2) How can possible ratings achieved on the nine-point scale of importance and performance illustrated in figure 18.6 be used to determine the relative priorities of any efforts at improvement?
 - (3) How did EXL Laboratories (see the worked-out example in chapter 18 of your prescribed book) go about the process of improving the level of service it offered its customers? Which aspects of its service needed urgent action or deserved the highest priority for improvement?
 - (4) What does the compilation of an importance-performance matrix entail and how can it be used to determine the relative priority of improvement activities?
 - (5) What actions should a business take in each of the following zones of the importance-performance matrix: appropriate, improve, urgent action, excess?
 - (6) Which performance objective is the most important? Some POM managers believe there is a generic “best” sequence of improvement. The trade-off theory may be under attack as some operations want to offer the market the best of both worlds. What is the best sequence of improvement?
-



FEEDBACK: ACTIVITY 13.3

- (1) *Questions 1 to 2. These questions deal with setting improvement priorities. Review the discussion by the authors of your prescribed book in chapter 18. Note the nine-point scale used for ranking the importance of factors and the ranking of performance of the operation in figure 18.6 of your prescribed book.*
 - (2) *Question 3. This question deals with the worked-out example of EXL laboratories. Work through the example and indicate whether you agree with their final conclusions. The use of an importance-performance matrix, as illustrated in the example on EXL Laboratories in your prescribed book, is an excellent way of determining where (in which areas of the business) improvement activities should be undertaken as a matter of urgency, and where they should be improved upon, maintained or perhaps even scaled down. In this case urgent action was required in the areas of cost and communications, while improvement areas identified were delivery speed and delivery dependability.*
 - (3) *Questions 4 and 5. These questions deal with setting the importance-performance matrix. Review the discussion by the authors of your prescribed book in chapter 18. Study figure 18.7 in your prescribed book for an illustration of such a matrix. (Note the nine-point scale as proposed in figure 18.6(b) of your prescribed book is used on the vertical axis, while the nine point scale as proposed in figure 18.6(a) of your prescribed book is used on the horizontal axis.) Note also the proposed actions if a factor falls into one of the four segregated zones.*
 - (4) *Question 6. This question deals with the sand cone theory. Note also the model of improvement as illustrated in figure 18.10.*
-

13.4 TWO DIFFERENT APPROACHES TO IMPROVEMENT



ACTIVITY 13.4

Study the third section of chapter 18 entitled “Approaches to improvement” in your prescribed book and then answer and/or complete the following:

- (1) Two particular approaches to, or strategies for, improvement which to some extent represent opposing philosophies, are breakthrough improvement, which entails and continuous improvement, which entails
 - (2) What is the potential impact of breakthrough improvements and why is the actual pattern of performance improvement achieved often significantly different from what was intended?
 - (3) Continuous improvement is a different approach to improvement, and is also known as “kaizen”. It entails
 - (4) How could the following continuous improvement (CI) abilities be promoted with associated behaviours: getting into the CI habit, focusing on CI, spreading the CI word, CI on the CI system, walking the CI talk, building the learning organisation?
 - (5) What are the major differences between breakthrough and continuous improvement with regard to their effect, pace, time frame, change, employee involvement, approach, stimulus, risks, practical requirements, effort orientation and evaluation criteria?
 - (6) What do the PDCA cycle (plan, do, check, act) and the DMAIC cycle (define, measure, analyse, improve, control) entail and why are they regarded as comparable to the continuous improvement approach?
 - (7) What does BPR (business process re-engineering) involve and why is it considered a typical radical breakthrough approach to improvement?
 - (8) What is the implication of the underlying assumption of BPR on the organisational structure of a business and how do the principles of BPR influence the management of an operation?
-



FEEDBACK: ACTIVITY 13.4

- (1) Questions 1 to 3. These questions deal with the two main improvement philosophies. Review the discussion by the authors of your prescribed book in chapter 18. Specifically, note the diagrammatic illustration of each together with a combined “breakthrough”/continuous improvement approach, as illustrated in figure 18.11 in your prescribed book.
- (2) Question 4. This question deals with building a continuous improvement capability. Review the discussion by the authors of your prescribed book in chapter 18. Specifically, note the six generic organisational abilities with their own set of constituent behaviours as listed in table 18.2.
- (3) Question 5. This question deals with the differences between breakthrough and continuous improvement. Review the discussion by the authors of your prescribed book in chapter 18. Specifically, note the characteristics of each as summarised in table 18.3.
- (4) Question 6. This question deals with improvement cycle models. Review the discussion by the authors of your prescribed book in chapter 18. Specifically, note the diagrammatic illustration of the PDCA and DMAIC cycles in figure 18.12. Finally, read the case study of “Six Sigma at Honeywell Southern Africa” in chapter 18 of your prescribed book and answer the questions asked at the end of the case study.
- (5) Questions 7 and 8. These questions deal with business process re-engineering (BPR). Review the discussion by the authors of your prescribed book in chapter 18. Note the diagrammatic illustration of BPR with its focus on functionally-based processes to reflect the natural processes that fulfil customer needs in figure 18.13. Also study the example

of the before (a) and after (b) re-engineering a consumer goods trading company as illustrated in figure 18.14. Finally, study the critical remarks made by the authors of your prescribed book concerning the shortcomings of BPR. Do you agree with them?

- (6) To summarise: Note that, while there is a great deal of talk today about business process re-engineering (BPR) and many businesses have climbed on the bandwagon, it should be noted that, at least from a theoretical perspective, BPR is considered a breakthrough rather than a continuous improvement approach. As pointed out in your prescribed textbook, the possible discrepancies between the intended improvements and those actually achieved in practice may, however, be considerable.
-

13.5 IMPROVEMENT TECHNIQUES



ACTIVITY 13.5

Study the fourth section of chapter 18 entitled “The techniques of improvement” in your prescribed book and then answer and/or complete the following:

- (1) Why is it said in your prescribed book that “all techniques described in this book can be regarded as ‘improvement’ techniques”?
 - (2) Input-output analysis involves understanding the and entails the three tasks of
 - (a) identifying the inputs and outputs of the process, such as,
 - (b) identifying the sources of the inputs (the suppliers) and the destination of the outputs (the customers/clients), such as, and
 - (c) clarifying the requirements of the internal customers/clients (who are served by the outputs from the process), such as, and
 - (d) clarifying the demands (requirements) the process makes on the internal suppliers (who provide the inputs to the process), such as What would such an analysis look like, in the case of Kaston Pyral Services Ltd in chapter 18 of your prescribed book?
 - (3) The use of process maps (flow charts) is a more detailed technique than the use of input-output diagrams; these diagrams only provide an overview of the process context of the improvement opportunities and are used because What would such a process map look like in the example of Kaston Pyral Services Ltd in chapter 18 of your prescribed book?
 - (4) Scatter diagrams entail but, however sophisticated their approach, they can only identify the existence of a relationship and not What would such a diagram look like, in the case of Kaston Pyral Services Ltd in chapter 18 of your prescribed book?
 - (5) Cause-effect diagrams (which are also known as “fish-bone” or Ishikawa diagrams) entail and the procedure for drawing involves the following steps: step 1, step 2, step 3 and step 4
 - (6) What suggestions are offered by the authors of the textbook on using cause-effect diagrams? What would such a diagram look like in the case of Kaston Pyral Services Ltd in chapter 18 of your prescribed book?
 - (7) The purpose of Pareto-analysis is to What would such a diagram look like in the case of Kaston Pyral Services Ltd in chapter 18 of your prescribed book?
 - (8) Why-why analysis entails What would such a diagram look like in the case of Kaston Pyral Services Ltd in chapter 18 of your prescribed book?
-



FEEDBACK: ACTIVITY 13.5

- (1) Questions 1 to 8. These questions deal with the typical improvement techniques (also known for their use in the quality circle process). Review the discussion by the authors of your prescribed book in chapter 18. Note the diagrammatic illustrations of a process map (flow chart) in figure 18.16, scatter diagram in figure 18.15, cause and effect diagram in figure 18.17, Pareto diagram in figure 18.18 and why-why analysis in figure 18.19 for the example of Kaston Pyral Services Ltd in chapter 18 of your prescribed book.
- (2) To summarise: Note that, as can be seen from the above, there are many techniques available that can be used to improve the whole or possibly only a part of the operation. We highlighted some of these above. Others are described in the different study units covering specific aspects or activities of production and operations management.



CHECK LIST

Now that you have completed study unit 13 on production and operations improvement, you should be able to do the following:

- Explain what measuring and improving the performance of the production and operations management system entails.
- Explain how production and operations managers decide where to start their improvement activities.
- Describe the various approaches to improvement which production and operations managers can use.
- Describe the improvement techniques which production and operations managers can use.
- Use your knowledge of, and insight into
 - measuring and improving the performance of the production and operations management system
 - where production and operations managers should start their improvement activities
 - the various approaches to improvement which production and operations managers can use
 - the improvement techniques that production and operations managers can use

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you appreciate the need for production and operations management improvement by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



SUMMARY

This study unit examined production and operations management improvement in general. Together with the next study unit entitled "Total quality management", it forms part of topic 8 which deals with the measurement and the improvement of the performance of the production and operations management system.



ASSESSMENT

- (1) Read the case study entitled “Durban Container Terminal congestion” at the end of chapter 18 in your prescribed book and then answer the question.
- (2) Complete study activities 1 to 4 at the end of chapter 18 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, others may even require you to visit your local equivalent business/organisation to investigate an aspect of the subject yourself.

Study unit 14

TOTAL QUALITY MANAGEMENT



KEY CONCEPTS

appraisal costs	contributes to quality
Crosby's "quality is free" and "zero defects" programmes	Deming's 14 points for quality improvement
Deming prize	European Quality Award (EQA)
European Foundation for Quality Management (EFQM)	EFQM excellence model
people, customer, society, results	enablers
quality gurus	key performance results
external failure costs	every person in the organisation contributes to quality
Feigenbaum's total quality control (TQC)	getting things right first time
internal customer-supplier	inspection
Ishikawa's quality circles and cause-and-effect diagrams	internal failure costs
micro operation	ISO 9000:2000 approach
optimum quality level	Juran's fitness for use
origins of TQM	Malcolm Baldrige National Quality Award
quality assurance (QA)	prevention costs
quality disillusionment	quality at the source
quality awards	quality droop
quality management	quality control (QC)
service level agreements (SLA)	quality systems and procedures
total quality management (TQM)	Taguchi's quality loss function (QLF)
TQM covers all parts of the organisation	TQM approach to improvement
TQM implementation	TQM meets the needs and expectations of the customers
TQM quality cost model	TQM philosophy
proactive – doing something before it happens	reactive – waiting for something to happen
design-in quality (getting it right first time)	inspect-in quality (appraisal driven)
Six Sigma approach to organising improvement	self-assessment
"Green Belt"	Six Sigma
	"Master Black Belt"
	"Black Belt"

GETTING AN OVERVIEW

This study unit covers the fifth, sixth, seventh and eighth learning outcomes of Topic 8. We shall discuss the TQM as an approach to the management of improvement, the TQM

approach itself, the implementation of TQM improvement programmes, and the quality award schemes that currently exist.

14.1 INTRODUCTION IN PRESCRIBED BOOK



READ

First read the introduction to chapter 20 in your prescribed book and note the basic composition of figure 20.1. This depicts a model of improvement activities in production/operations management. You need to memorise this figure because it serves as a mind map for the remainder of the study unit. After you have done this, read the points listed under the question: "Where did the idea of total quality management (TQM) come from?", the points listed under the question: "What are the main differences between traditional quality management and TQM?", the few points listed under the question: "What is the role of ISO 9000 in TQM?", the point listed under the question: "What are the main implementation issues in TQM initiatives?" and the few points listed under the question: "How do quality awards and models contribute towards TQM?" in the summary answers to key questions at the end of chapter 20.

14.2 ORIGINS OF THE TOTAL QUALITY MANAGEMENT (TQM) APPROACH



ACTIVITY 14.1

Read the case study entitled "Taxing quality" in chapter 20 of your prescribed book and then answer the following questions:

- (1) Why is effectiveness in the public sector just as important as it is for the private sector?
 - (2) What was the common set of issues which organisations such as Aarhus CT had to face and deal with when organising its quality initiative?
-



FEEDBACK: ACTIVITY 14.1

- (1) *Whether they deal with departments/institutions from the public sector (government, municipalities, etc) or businesses/enterprises from the private or commercial sector, customers expect and demand "quality" products and/or services. Effective operations are a key factor in the manufacture of such products or delivery of such services. In the case of Aarhus CT, which collects taxes, the company must do this in a professional and efficient manner and its users (customers/clients) "are entitled to fair control and collection, fast and efficient case work, service and guidance, flexible employees and a professional telephone service".*
- (2) *The common set of decisions which organisations such as Aarhus CT face when organising their quality initiatives were: (a) What are the customer's/client's perceptions, needs and requirements (that is, what he/she should [or should not] receive from the operation)? (b) How does one measure the effects of the quality initiative? (c) What is the best way to design the processes to encourage a quality environment? (d) How should one*

organise the whole quality initiative (note: with the involvement of staff)? (e) How can an organisation continuously improve?



ACTIVITY 14.2

Study the first section of chapter 20 entitled “TQM and the management of improvement” in your prescribed book and then answer and/or complete the following:

- (1) Armand Feigenbaum is credited with having introduced the notion of TQM in 1957, when he defined it as
 - (2) What were the individual contributions of the quality gurus such as Feigenbaum, Deming, Juran, Ishikawa, Taguchi and Crosby, which led to further development of the TQM improvement approach?
 - (3) What are the strengths and weaknesses of each of the approaches put forward by these quality gurus?
-



FEEDBACK: ACTIVITY 14.2

- (1) *Question 1. This question deals with the first time TQM was mentioned. Review the discussion by the authors of your prescribed book in chapter 20. While Feigenbaum is credited with having introduced the notion of total quality management, the contributions of the other quality gurus, such as Deming, Juran, Ishikawa, Taguchi and Crosby, were definitely fundamental to its further development as a holistic, comprehensive approach or philosophy to business improvement.*
 - (2) *Questions 2 and 3. These questions deal with the origins of TQM. Review the discussion by the authors of your prescribed book in chapter 20. Also note the critical remarks made by the authors of your prescribed book in chapter 20 regarding a possible weakness of TQM’s dependence on the work of the so-called “quality gurus”. Do you agree that, because some of the “quality gurus” were consultants, they promoted their ideas in the face of an “evidence-driven approach to examining the behaviour of organizations”? We don’t know whether we’re convinced by this argument; indeed, this argument appears to be based on jealousy (emanating from academia!). Finally, study figure 20.2 in your prescribed book, which illustrates the natural extension of earlier approaches to quality management to what today is known as Total Quality Management (TQM).*
 - (3) *To summarise: note that a very exciting approach to improvement, which has become very popular over the last few years in many companies all over the world, including South Africa (and which does not limit itself to a single function, department, section, operation, group of people or any person in particular) is known as “total quality management”. Quality itself, however, is not the only concern of the approach: instead, it covers all aspects of the operation’s performance because it is seen as a holistic, comprehensive approach to the improvement of the business.*
-

14.3 THE NATURE OF THE TQM APPROACH



ACTIVITY 14.3

Study the second section of chapter 20 entitled “What is TQM?” in your prescribed book and then answer and/or complete the following:

- (1) The authors of your prescribed book note that, while the quality gurus appeared to provide different solutions to improving organisations, they were all, and TQM is today seen as a philosophy which is concerned with and which attempts to move
 - (2) What are the seven basic fundamentals (or explanation of the concept of “totality” in TQM) of the TQM approach?
 - (3) How does the TQM approach try to meet the needs and expectations of its customers/clients more effectively? What practical examples of your own can you give of such an exceptional level of product/service commitment to customers/clients by companies?
 - (4) TQM covers all parts of the organisation, which means and utilises the concept of the internal customer/client and supplier, by stressing that which, in effect, means defining what constitutes error-free service and/or products.
 - (5) Service level agreements (SLAs) are used to My own practical example of their use is
 - (6) What are the implications for individual employees and management in accepting the TQM notion that every person in the organisation contributes to quality?
 - (7) What are the four main components of the cost of quality and how does the traditional quality cost model define the optimum quality effort?
 - (8) What are the criticisms of the traditional quality cost model and how could their correction modify the optimum-quality effort calculation?
 - (9) How do the proponents of TQM feel about the issue of the cost of quality and what effect could their approach of emphasising prevention rather than appraisal have on the total quality costs if this approach was followed over a period of time?
 - (10) The phrase “getting things right first time” is in line with the TQM approach to the relationships between the different categories of quality costs and suggests the way in which quality must be managed. It shifts the emphasis from to and reflects a movement from an approach, which is appraisal driven, to a approach which embodies the phrase “getting things right first time”.
 - (11) Why are quality systems and procedures important for improving quality and what do the three levels of documentation in a quality system involve?
 - (12) What does the ISO 9000 (2000) quality management system entail and what are the advantages associated with this quality management system?
-



FEEDBACK: ACTIVITY 14.3

- (1) *Questions 1 and 2. These questions deal with what is understood by TQM. Review the discussion by the authors of your prescribed book in chapter 20. Essentially, the TQM approach, as a holistic, comprehensive management philosophy for a business, endeavours to excel at meeting the needs and expectations of its customers/clients; it covers and includes all parts of the organisation; it involves every person in the business; it examines all costs related to quality; it strives “to design quality in” rather than “inspecting it in” (“to get things right the first time”); it uses quality system standards such as those based on ISO 9000 to support quality and improvement and, finally, it initiates and supports a continuous process of improvement in the organisation.*
- (2) *Questions 3 to 5. These questions deal with the first two basic fundamentals of TQM: TQM meets the needs and expectations of customers/clients, and TQM covers all parts of the organisation. Review the discussion by the authors of your prescribed book in chapter 20. Then study figure 20.3, which illustrates the internal customer-supplier relationship between micro operations (which is what TQM stresses). Also read the case study of*

“Hewlett-Packard’s internal customer check list” in chapter 20 of your prescribed book and answer the questions asked at the end of the case study. Study figure 20.4 in your prescribed book, which illustrates the increasing nature of costs of rectifying errors as time goes by in the development process of new products. Finally, note the critical commentary by the authors of your prescribed book in chapter 20 about the drawbacks of SLAs. (These being that they work against building partnerships and their lack of emphasis on softer aspects of performance such as “friendliness”.) Do you agree?

- (3) *Question 6. This question deals with the third basic fundamental of TQM, namely, every person in the organisation contributes to quality. Review the discussion by the authors of your prescribed book in chapter 20. Specifically, note the statement by Konosuke Matsushita as quoted by the authors of your prescribed book in chapter 20 in the section dealing with the contribution of everyone to quality. Note the remarks made about the shift in attitude needed in “Western management” to view “employees as the most valuable intellectual and creative resource” in the organisation. Too often our experiences are, as Konosuke Matsushita says, little more than “getting the ideas out of the heads of bosses into the hands of labour”. Management is not responsive to contributions by employees, but pays lip service to the idea of participative management. Do you agree? What has your experience been like as far as participative management is concerned? Also read the case study of “South African Weather Service – Progress on TQM” in chapter 20 of your prescribed book and answer the questions asked at the end of the case study. Finally, note the critical remarks made by the authors of your prescribed book in chapter 20 regarding what is meant by “empowerment” in a TQM context. To link up again with the theme discussed earlier in this paragraph regarding employee involvement: the authors of your prescribed book argue that empowerment usually means little more than increasing the amount of discretion that employees have over minor details of their work, rather than genuinely offering “opportunities for employees to gain or consolidate control over the broader environment in which their work is located”. Do you agree?*
- (4) *Questions 7 to 9. These deal with the fourth basic fundamental of TQM: taking into consideration all the costs of quality. Review the discussion by the authors of your prescribed book in chapter 20. Then study figure 20.5 in your prescribed book, which illustrates in (a) the traditional cost of a quality model; and in (b) the model with the adjustments to reflect the three TQM criticisms. These are described by the authors of your prescribed book and centre on the concept of “an acceptable quality level”, obtaining the precise costs of quality which is not as straightforward as it is sometimes made out to be, and the underestimation of failure or error costs. Also study the case study of “Deliberate defectives” in chapter 20 of your prescribed book and answer the questions asked at the end of the case study.*
- (5) *Question 10. This question deals with the fifth basic fundamental of TQM, namely, “getting things right first time”. Review the discussion by the authors of your prescribed book in chapter 20. Then study figure 20.6 in your prescribed book, which illustrates the relationships between the categories of quality cost with a shift from the emphasis on “reactive” (waiting for something to happen and inspect-in quality) to “proactive” (doing something before it happens and “getting it right first time” quality).*
- (6) *Questions 11 and 12. These questions deal with the sixth basic fundamentals of TQM namely, developing the systems and procedures which support quality and improvement. Review the discussion by the authors of your prescribed book in chapter 20. Note the critical remarks made by the authors of your prescribed book in chapter 20 about ISO 9000:2000 in encouraging “management by manual”. Note what they say about the expensive and time-consuming exercise of documenting processes, the excessive time and cost of achieving and maintaining ISO 9000 registration, and its formulaic nature, which encourages “recipes” rather than a customised and creative approach to managing operations improvement. Note that the seventh basic fundamental of TQM, namely, developing a continuous process of improvement, was discussed in study unit 13.*

- (7) *To summarise: Note that, essentially, the TQM approach, as an overall, comprehensive management philosophy for a business or other institution, endeavours to excel at meeting the needs and expectations of its customers/clients. It covers and includes all parts of the organisation; it involves every person within that organisation; it examines all costs related to quality; it strives “to design quality in” rather than “inspecting it in” (“to get things right the first time”); it uses quality systems and procedures such as the ISO 9000:2000 to support quality and improvement and, finally, it initiates and supports a continuous process of improvement in the organisation.*
-

14.4 THE IMPLEMENTATION OF TQM



ACTIVITY 14.4

Study the third section of chapter 20 entitled “Implementing improvement programmes” in your prescribed book and then answer and/or complete the following:

- (1) Many TQM initiatives launched by organisations do not always meet their expectations and, according to some surveys, many companies often end up disillusioned with TQM. This may occur because two types of failures, namely, and may follow the implementation of TQM.
 - (2) What factors appear to influence the eventual success of TQM improvement programmes and how can they be reinforced in order to avoid implementation failures?
 - (3) What does the Six Sigma approach to organising improvement entail? Which criticisms are levelled at the Six Sigma approach and how are they countered by Six Sigma proponents?
 - (4) Why do some TQM improvement programmes lose their effectiveness over time even though, initially, their implementation was successful? What steps can be taken to avoid such occurrences?
-



FEEDBACK: ACTIVITY 14.4

- (1) *Questions 1 and 2. These questions deal with implementing TQM improvement programmes. Review the discussion by the authors of your prescribed book in chapter 20. While TQM improvement programmes may, initially, be implemented successfully (that is, when all factors that may influence their implementation are taken into consideration and, where necessary, reinforced), over time they can lose their effectiveness in terms of improving organisational performance. (In other words, disillusionment sets in and steps are needed to revitalise the whole improvement programme.) Note the factors which may act as quality barriers, as listed in table 20.1 of your prescribed book. Of particular interest are the first three: top-management commitment, a too narrow view or understanding of quality, and organisational boundaries and specialisation. Finally, note that different types of improvement groups (that is, quality circles, quality improvement team or task force) may have different characteristics in terms of task improvement selection, membership of group, management direction, and urgency of improvement task. See figure 20.7 in your prescribed book and note the importance of the sustainability of TQM programmes.*
- (2) *Question 3. This question deals with the Six Sigma approach to organising improvement. Review the discussion by the authors of your prescribed book in chapter 20. Note the emphasis on training members of staff to become a specially trained cadre of practitioners, experts or internal consultants (with terms such as Master Black Belt, Black belt and Green Belt denoting their level of expertise). Criticisms of Six Sigma are that it may*

be too hierarchical, that the use of martial arts terms is somewhat dubious, and that the training it requires is expensive, especially for small businesses. The proponents of Six Sigma counter these criticisms by arguing that improvement activities are generally neglected, that if Six Sigma is to be taken seriously significant investments must be made, and that, in fact, having experienced practitioners to run improvement projects far outweighs the cost.

- (3) Question 4. This question deals with the situation where TQM loses its effectiveness over time. Review the discussion by the authors of your prescribed book in chapter 20. Review figure 20.7, which illustrates the pattern of some TQM programmes: people run out of enthusiasm and eventually end up getting disillusioned – this is when efforts have to be taken to revitalise the programme. Finally, note the critical remarks made by the authors of your prescribed book in chapter 20 about the fundamental flaws in the TQM philosophy. Their criticisms centre on: (a) the creation of a “quality bureaucracy”; (b) the fact that TQM is incompatible with other radical improvement approaches such as BPR; (c) the continued exploitation of workers despite liberal concepts of empowerment. Do you agree? The following quotation by the authors of your prescribed book in chapter 20 hits quite hard, but is very often how employees actually feel: it “... is like putting a vacuum cleaner next to a worker’s brain and sucking out ideas. They don’t want to rent your knowledge anymore, they want to own it – in the end that makes you totally replaceable”. What is your response to this?
- (4) To summarise: Note that while TQM improvement programmes may initially be implemented successfully (that is, all factors which may influence their implementation are taken into consideration and, where necessary, reinforced), over time they may lose their effectiveness as far as improving organisational performance is concerned. (In other words, disillusionment sets in and steps are needed to revitalise the whole improvement programme.)

14.5 QUALITY AWARD SCHEMES



ACTIVITY 14.5

Study the fourth section of chapter 20 entitled “Quality awards” in your prescribed book and then answer and/or complete the following:

- (1) What is the purpose of quality award schemes and how can they encourage quality improvement?
- (2) The three best-known quality award schemes are the Deming prize, which involves, the Malcolm Baldrige National Quality Award, which involves and the European Foundation for Quality Management (EFQM) and their European Quality Award (EQA), which involves
- (3) What does the EFQM Excellence Model involve and how is self-assessment by organisations done in order to measure management’s progress in changing the organisation and achieving the benefits of TQM?



FEEDBACK: ACTIVITY 14.5

- (1) Questions 1 and 2. These questions deal with quality awards. Review the discussion by the authors of your prescribed book in chapter 20. Note the ten major assessment categories of the Deming prize, and the main examination categories of the Malcolm

Baldrige National Quality Award. The purpose of a quality award scheme is to encourage quality improvement and TQM. Quality itself is seen as an important integrator of many aspects of production and operations management and quality awards recognise the outstanding quality improvement efforts of certain businesses.

- (2) Question 3. This question deals with the EFQM. Review the discussion by the authors of your prescribed book in chapter 20. Note the diagrammatic illustration of the model in figure 20.8 of your prescribed book and the nine elements of the model (which, with an own-organisation weighting done in a rational and systematic manner, form the basis for self-assessment). These include five enablers, namely leadership, policy and strategy, its people, partnerships and resources, and processes – these lead the four results, which are people, customer, society and key performance areas.



CHECK LIST

Now that you have completed study unit 14 on total quality management, you should be able to do the following:

- Explain TQM as an approach to managing improvement.
- Explain what the TQM approach entails.
- Explain how TQM improvement programmes can be implemented.
- Name the quality award schemes that currently exist and explain their purpose.
- Use your knowledge of, and insight into
 - TQM as an approach to managing improvement
 - the TQM approach itself
 - the implementation of TQM improvement programmes
 - the quality award schemes that currently exist

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you appreciate the need for total quality management by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



SUMMARY

In this study unit, we examined total quality management. Together with the previous study unit entitled “The general nature of production and operations improvement”, it formed part of topic 8, which deals with the measurement and improvement of the production and operations management performance system.



ASSESSMENT

- (1) Read the case study entitled “The Waterlander Hotel” at the end of chapter 20 in your prescribed book and then answer the questions asked at the end of the case study.
- (2) Complete study activities 1 to 4 at the end of chapter 20 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences of a particular business/organisation. Finally, others may even require you to visit a local business/organisation to investigate an aspect of the subject yourself.

TOPIC 9

MAINTAINING THE PRODUCTION AND OPERATIONS MANAGEMENT SYSTEM

AIM

To provide you with an understanding of what the maintenance of the production and operations management system entails and why it is important for production and operations management.



LEARNING OUTCOMES

Once you have worked through this topic, you should be able to do the following:

- Describe what a system failure entails and explain how failures in operations can be measured.
- Describe what failure detection and analysis involve.
- Explain how to improve the reliability of the production and operations system.
- Describe what recovery from failure involves.
- Use your knowledge of, and insight into
 - system failure and measuring failures in operations
 - failure detection and analysis
 - how to improve the reliability of the production and operations system
 - recovery from failure

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you appreciate the need for the maintenance of the production and operations management system by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.
-



TOPIC CONTENTS

Study unit 15 Failure prevention and recovery
(chapter 19)

Study unit 15

FAILURE PREVENTION AND RECOVERY



KEY CONCEPTS

accident investigation	AND nodes/OR nodes
approaches to maintenance	availability (A)
business continuity	complaint analysis
condition-based maintenance (CBM)	critical incident analysis
critical incident technique (CIT)	customers'/clients' failures
design failures	designing out fail points
errors	violations
facilities failures	fail-safeing
failure analysis	failure as opportunity concept
failure detection mechanisms	failure distributions
failure mode and effect analysis (FMEA)	failure over time – bathtub curve
failure prevention and recovery	failure planning
fault-tree analysis	failure rates
improving the operation's reliability	improving the dependability of operations
maintenance	mean time between failures (MTBF)
mean time to repair (MTTR)	measuring failure
minimise likelihood of failure	mixed maintenance strategies
preventative maintenance (PM)	product liability
recovery from failure	redundancy
reliability measures	reliability-centred maintenance (RCM)
run to breakdown (RTB)	people failures
risk priority number (RPN)	system failure
supplier failures	
total productive maintenance (TPM)	

GETTING AN OVERVIEW

This study unit covers the learning outcomes of topic 9. We shall discuss system failure and measuring failures in operations, failure detection and analysis, improving the reliability of the production and operations system, and recovery from failure.

15.1 INTRODUCTION IN PRESCRIBED BOOK



READ

First read the introduction to chapter 19 in your prescribed book and note the basic composition of figure 19.1. This depicts a model of improvement activities in production/

operations management. You need to memorise this figure, because it serves as a mind map for the remainder of the study unit. After you have done this, read the point listed under the question: “Why do operations fail?”, the few points listed under the question: “How is failure measured?”, the points listed under the question: “How can failure and potential failure be detected and analysed?”, the points listed under the question: “How can operations improve their reliability?” and the two points listed under the question: “How should operations recover when failure does occur?” in the summary answers to key questions at the end of chapter 19.

15.2 SYSTEM FAILURES



ACTIVITY 15.1

Study the first section of chapter 19 entitled “Operations failure” in your prescribed book and then answer and/or complete the following:

- (1) Why are some types of failures considered more serious than others?
- (2) Organisations need to discriminate between failures and pay particular attention to those which are either or because and, in order for them to do this, they must understand and be able to
- (3) What three broad categories of failures occur in operations? How can design failures, facilities failures, people failures, supplier failures and customer/client failures negatively impact on an operation and its objectives?
- (4) Why is it said that failures are not the result of random chance; their root cause is usually human failure? What is the implication of this in terms of viewing failure as an opportunity?
- (5) What are the three main ways of measuring failure and how are they interrelated?
- (6) The failure rate is calculated as the number of failures over a period of time and can be measured as a percentage of the number of products tested with the following formula, or as the number of failures over time tested with the formula My own practical example of such a calculation is
- (7) Failure, for most parts of an operation, is a function over time, which means, and the curve which describes failure probability of this type is called and comprises the three distinct stages of infant mortality or early life stage where, normal life stage where and wear-out stage where
- (8) How do the bathtub curves of two operations with slightly different characteristics similar to curves A, B and C as depicted in figure 19.2 of your prescribed book differ from each other? What are the implications of such differences for the predictability of failure and maintenance planning?
- (9) What would the bathtub curve for an operation which is more dependent on human resources than on machine technology look like? What are the dangers of staff complacency?
- (10) Reliability measures, where the importance of any particular failure is determined partly by the effect it has on the performance of the whole operation or system. It is calculated by means of the following formula: My own practical example of such a calculation is

- (11) Why does the reliability of an operation or system decrease as the number of interdependent components increase, even if the reliability of the individual components reaches 99 per cent?
- (12) An alternative measure of failure is to calculate the mean time between failures (MTBF) by using the following formula My own practical example of such a calculation is
- (13) Availability is the degree to which an operation is ready to work and, when it is measured, indicates the operating time excluding the consequence of failure. To calculate this, the following formula is used: My own practical example of such a calculation is
- (14) Production and operations management may entail three sets of activities which relate to failure, namely failure detection and analysis, which involves and means, improving the system reliability, which involves and means, and recovery, which involves and means



FEEDBACK: ACTIVITY 15.1

- (1) Questions 1 to 2. These questions deal with why things fail. Review the discussion by the authors of your prescribed book in chapter 19. Read the case study "Two million to one" (focusing on a facility failure) in chapter 19 of your prescribed book and answer the questions asked at the end of these case studies.
- (2) Questions 3 to 13. These questions deal with failure as an opportunity and the measurement of failure. Review the discussion by the authors of your prescribed book in chapter 19. Study: the worked-out examples of the calculation of the failure rate of a batch of electronic components; the calculation of the reliability of a whole system with a number of interdependent components; the calculation of MTBF for the previous example of electronic components; and the calculation of the availability of a large platform colour laser printer in chapter 19. Indicate whether you agree with the calculations and conclusions. Also, study figure 19.2 in your prescribed book and note the so-called "bathtub" curves for a part with very predictable failure characteristics (curve A), one which has less predictable failure characteristics (curve B) and one for a service operation (curve C). Again, study figure 19.3 in your prescribed book and note the relationship between the average reliability of all components and the reliability of the total system. As shown, even if the average reliability of individual components is 0.99, the reliability of the total system decreases dramatically as the number of components in the system increases. For instance, in the case of a system of which the components have an individual reliability of 0.99, the total system's reliability with 10 parts decreases to 0.90, with 50 parts to 0.60, with 100 parts to approximately 0.35, with 200 parts to approximately 0.26, and with 400 parts to approximately 0.03. Finally, read the case study of "Leading light" in chapter 19 of your prescribed book and answer the questions asked at the end of the case study.
- (3) Question 14. This question deals with failure prevention and recovery. Review the discussion by the authors of your prescribed book in chapter 19. Also, study figure 19.4 in your prescribed book which illustrates the various tasks of failure prevention and recovery in the form of: (a) failure detection and analysis; (b) improving the system's reliability; and (c) recovery.
- (4) To summarise: Note that system failures can, and do occur in any type of operation. Understanding what kinds of failures are occurring and why, trying to reduce the chances of such failures and/or minimising their effects, and recovering when they do occur, all provide the basis for effective failure prevention and efficient recovery. These are the two things which are particularly important for the maintenance of the production and operations management system.

15.3 DETECTING FAILURES AND ANALYSING THEIR CAUSES



ACTIVITY 15.2

Study the second section of chapter 19 entitled “Failure detection and analysis” in your prescribed book and then answer and/or complete the following:

- (1) Why are failure detection and analysis important for production and operations management?
 - (2) Failure detection entails and failure analysis
 - (3) What mechanisms are available to production and operations managers for the proactive detection of failures?
 - (4) What do each of the following failure analysis techniques and approaches entail: accident investigation, product liability, complaint analysis, critical incident analysis, failure mode and effect analysis (FMEA), and fault-tree analysis?
-



FEEDBACK: ACTIVITY 15.2

- (1) *Questions 1 to 4. These questions deal with failure detection and analysis. Review the discussion by the authors of your prescribed book in chapter 19. Note the critical remarks made by the authors of your prescribed book in chapter 19 concerning the less than 100 per cent reliability of inspection alone. Do you agree? Study the worked-out example of the calculation of a risk priority number (RPN) for the transportation company in chapter 19 of your prescribed book and indicate whether you agree with the calculations and conclusion. Also note the example of the use of fault-tree analysis in the case of serving below-temperature food to customers in figure 19.5.*
 - (2) *To summarise: Note that not only is it important to detect failures when they occur or even, hopefully, to be forewarned of the possibility of failures before they occur (this activity is referred to as “failure detection”), it is also important to understand why such failures have occurred or probably will occur (this activity is referred to as “failure analysis”).*
-

15.4 IMPROVING THE RELIABILITY OF THE PRODUCTION AND OPERATION SYSTEM



ACTIVITY 15.3

Study the third section of chapter 19 entitled “Improving process reliability” in your prescribed book and then answer and/or complete the following:

- (1) What steps can be taken to prevent failures from occurring in the production and operations system in the first place?
- (2) “Designing-out fail points” means My own practical example of its use is
- (3) “Redundancy” means and the reliability of a component, together with its back-up, is calculated by using the following formula My own practical example of such a calculation is
- (4) What does the concept of “fail-safeing” (called “poka-yoke” in Japan) entail and which typical poka-yoke devices can be used?

- (5) Fail-safeing in service operations is done by fail-safeing the server, which means, and fail-safeing the customer/client, which means My own practical examples of each of these are
 - (6) The maintenance of physical facilities involves, and six benefits of these benefits of maintenance are,,,,, and
 - (7) What are the three basic approaches to maintenance and how could a combination of maintenance strategies or mixed maintenance strategies be used?
 - (8) What is the relationship between breakdown and preventative maintenance and where, according to the traditional cost of the maintenance model, would the optimum level of preventative maintenance be?
 - (9) Should routine preventative maintenance tasks be carried out by the operators themselves? If the real costs of breakdowns are considered, where, according to an adapted cost of maintenance model, would the optimum level of preventative maintenance be?
 - (10) What effect could the shape of the failure probability distribution curve of a facility have on the possible benefits of preventative maintenance?
 - (11) What does total productive maintenance (TPM) entail?
 - (12) TPM is seen as a natural extension of the evolution from run-to-breakdown to preventative maintenance, and adopts and principles, as well as a approach to failure prevention.
 - (13) What are the five goals of TPM and how can they help to establish a good maintenance practice?
 - (14) What does reliability-centred maintenance (RCM) involve and in what circumstances would this approach be more appropriate?
-



FEEDBACK: ACTIVITY 15.3

- (1) Questions 1 to 5. These questions deal with the first three ways of improving a system's reliability, namely, designing fail points, redundancy and fail-safeing. Review the discussion by the authors of your prescribed book in chapter 19. Study the worked-out example of the calculation of the reliability of the food manufacturer who now decides it needs a second cheese depositor in chapter 19 and indicate whether you agree with the calculations. Finally, note the critical remarks made by the authors of your prescribed book concerning the "rationality" of preventing failures. In practice, however, certain types of failures have higher negative impacts and are therefore seen to be of greater priority – for example, expenditure on the roads and an advance train protection system. Do you agree with this sort of analysis?
- (2) Questions 6 to 10. These questions deal with the fourth way of improving a system's reliability namely, maintenance. Review the discussion by the authors of your prescribed book in chapter 19. Read the case studies of "Keep left" in chapter 19 of your prescribed book and answer the questions asked at the end of the case study. Also study figure 19.6, which illustrates an example of a mixture of maintenance approaches used in the case of a motor car namely, preventative, run-to-breakdown and condition-based maintenance. Then study figure 19.7, which illustrates the two views of maintenance costs, namely (a) one model of the costs associated with preventative maintenance with an optimum level of maintenance; and (b) one model where routine preventative maintenance tasks are carried out by operators, and where the real cost of breakdown is considered with its optimum level of preventative maintenance at a higher level. Also study figure 19.8, which illustrates failure curves for two machines A and B and carefully note the implications regarding the probability of the two machines breaking down.

- (3) Questions 11 to 13. These questions deal with total productive maintenance (TPM). Review the discussion by the authors of your prescribed book in chapter 19.
 - (4) Question 14. This question deals with reliability-centred maintenance (RCM). Review the discussion by the authors of your prescribed book in chapter 19. Note that, other than in the case of TPM, which recommends preventative maintenance when it is not necessarily appropriate, RCM uses the pattern of failure for each type of failure mode of a part of a system to determine which particular approach to maintenance will be used. Study figure 19.9 in your prescribed book for the example of a simple shredding process with three different modes of failure (cutters worn out, cutters damaged by stones, cutters shaken loose) and note the three different failure patterns and recommended action.
 - (5) To summarise: Note that continuously improving the reliability of the production and operations system may help to prevent failures from occurring in the first place. This may be done by designing out fail points, building redundancy into the operation, fail-safeing and maintenance.
-

15.5 RECOVERING FROM FAILURES



ACTIVITY 15.4

Study the fourth section of chapter 19 entitled “Recovery” in your prescribed book and then answer and/or complete the following:

- (1) Recovery in operations entails and is important in a case where actual failures do occur, because
 - (2) How can recovery procedures shape customers'/clients' perceptions of failure? What effect can an effective response to failure have on customer/client satisfaction and loyalty?
 - (3) What are the implications of recovery in service operations in terms of customers'/clients' perceptions and/or experiences and how can these implications be dealt with?
 - (4) What does failure planning entail and how would each of its stages (discovery, acting, learning and planning) help the operation to recover from failure?
 - (5) What does the concept of “business continuity” include and how can a business respond to disasters or critical malfunction (which may interrupt the normal business activity and even stop the entire organisation)?
-



FEEDBACK: ACTIVITY 15.4

- (1) Questions 1 to 3. These questions deal with failure recovery. Review the discussion by the authors of your prescribed book in chapter 19. Read the case study of “Pick n Pay extortion attack” in chapter 19 of your prescribed book and answer the questions at the end.
- (2) Question 4. This question deals with failure planning. Review the discussion by the authors of your prescribed book in chapter 19. Then study figure 19.10 for a diagrammatic illustration of the various stages of failure planning. Also read the case study of “Slamming the door” in chapter 19 of your prescribed book and answer the questions asked at the end of the case study.
- (3) Question 5. This question deals with business continuity. Review the discussion by the authors of your prescribed book in chapter 19. Note the importance of this relatively “new concept” after the attack on the World Trade Centre and other targets in America on 11 September 2001 by religious fanatics. 9/11 led many organisations to re-examine their

planned procedures to so-called disasters; such procedures may include a whole range of things, but all basically interrupt the normal business activity and any such interruption is deemed to be serious.

- (4) *To summarise: Note that, while preventing failures is extremely important, this should not be the exclusive focus of production and operations managers. Failure planning should include the creation of procedures which will enable the operation to recover from failures with minimal disruption and/or with minimal customer/client dissatisfaction.*



CHECK LIST

Now that you have completed study unit 15 on failure prevention and recovery, you should be able to do the following:

- Describe what system failure entails and explain how failures in operations can be measured.
- Describe what failure detection and analysis involve.
- Explain how to improve the reliability of the production and operation system.
- Describe what recovery from failure entails.
- Use your knowledge of, and insight into
 - system failure and measuring failures in operations
 - failure detection and analysis
 - improving the reliability of the production and operation system
 - recovery from failure

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you appreciate the need for failure prevention and recovery by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



SUMMARY

This study unit examined failure prevention and recovery. While the topic of this study unit is “Maintaining the production and operations management system”, it should now be clear that maintenance itself is only one of the ways in which an operation’s reliability may be improved.



ASSESSMENT

- (1) Read the case study entitled “Eskom load shedding” at the end of chapter 19 in your prescribed book and then answer the questions asked.
- (2) Complete study activities 1 to 4 at the end of chapter 19 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experi-

ences of a particular business/organisation. Finally, others may even require you to visit a local equivalent business/organisation to investigate an aspect of the subject yourself.

TOPIC 10

NEW CHALLENGES TO AND CONTEMPORARY ISSUES IN PRODUCTION AND OPERATIONS MANAGEMENT

AIM

To provide you with an understanding of what some of the new challenges and contemporary issues in production and operations management entail and why they are important.



LEARNING OUTCOMES

Once you have worked through this topic, you should be able to do the following:

- Explain the impact of the globalisation of markets, supply bases and the “state-of-mind” of production/operations managers.
- Explain the changing view of corporate social responsibility (CSR) which all types of businesses must adopt and the role of production/operations managers in establishing ethical values.
- Explain the environmental responsibility of businesses and the impact that production/operations management decisions may have on the environment and the impact that environmental regulatory frameworks have on production/operations managers.
- Explain the influence of increasingly rapid and difficult-to-predict technology developments on production/operations management.
- Explain the emergence of the concept of “knowledge management” and the production/operations manager as the key custodian of process technology.
- Use your knowledge of, and insight into
 - the globalisation challenge to production and operations management
 - the corporate social responsibility challenge to production and operations management
 - the environmental responsibility challenge to production and operations management
 - the technology development challenge to production and operations management
 - the “knowledge management” challenge to production and operations management

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions.

- Demonstrate that you understand the new challenges and contemporary issues and the impact these have on production and operations management by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



TOPIC CONTENTS

Study unit 16 The production and operations management challenge
(chapter 21)

Study unit 16

THE PRODUCTION AND OPERATIONS MANAGEMENT CHALLENGE



KEY CONCEPTS

impact of globalisation	globalisation of markets and supply bases
international location	regional operations
home country operations	combined regional and global operations
global coordinated operations	ethical values
coordinated globalisation movement	environmental regulatory frame works
social responsibility	environmental burden (EB)
environmental responsibility	P – population size
environmental impact	T – technology
environmental management	ISO 14000
$EB = P \times A \times T$	technology developments
A – affluence of the population	sustainable technologies
green reporting	data, information and knowledge
ecological footprint	tacit knowledge
disruptive technologies	production and operations management body of knowledge (POMBOK)
concept of “knowledge management”	
explicit knowledge	
PO manager as custodian of process	
technology	

GETTING AN OVERVIEW

This study unit covers the learning outcomes of topic 10. We shall discuss the globalisation challenge to production and operations management; the corporate social responsibility (CSR) challenge to production and operations management; the environmental responsibility challenge to production and operations management; the technology development challenge to production and operations management; and the “knowledge management” challenge to production and operations management.

16.1 INTRODUCTION IN PRESCRIBED BOOK



READ

First read the introduction to chapter 21 in your prescribed book and note the basic composition of figure 21.1. This figure depicts a model of the challenges in production/operations management. You need to memorise this figure because it serves as a mind map for the remainder of the study unit. After you have done this, read the points listed under the

question: "What impact will globalization and an increasingly international perspective on business have on operations management?", the few points listed under the question: "How does a wider view of social responsibility influence operations management?", the points listed under the question: "Why is it important for operations management to take its environmental responsibility seriously?", the points listed under the question: "What will new technologies mean for operations management?" and the two points listed under the question: "Does 'knowledge management' have a role in operations management?" in the summary answers to key questions at the end of chapter 21.

16.2 THE GLOBALISATION CHALLENGE TO PRODUCTION AND OPERATIONS MANAGEMENT



ACTIVITY 16.1

Study the first two sections of chapter 21 entitled "Why challenges" and "Globalization" in your prescribed book and then answer and/or complete the following:

- (1) POM is at the forefront of almost all business challenges of which this section lists five for consideration. What is meant by the terms "globalisation" and "ethical globalisation" and how can it impact on production/operations management? Can one find high ethical standards in today's global village especially in terms of a "connectedness" by shared values and norms?"
 - (2) How can production/operations managers respond to globalisation challenges in the following key production/operations decision areas: product/service design, network design, layout of facilities, process technology, job design, planning and control (including MRP, JIT and project planning and control), capacity planning and control, inventory planning and control, supply chain planning and control, quality planning and control and TQM, and failure prevention and recovery?
 - (3) Why is there an anti-globalisation movement and what could the potential impact of this be on production/operations management?
-



FEEDBACK: ACTIVITY 16.1

- (1) *Questions 1 to 3. These questions deal with a list of challenges (which is incomplete) with the focus on globalisation, the impact on production/operations management and the anti-globalisation movement. Ethical globalisation is an ever increasing priority but it is very doubtful whether one can expect "high ethical standards" if the current international corruption indices are an indication to go by. Review the discussion by the authors of your prescribed book in chapter 21 and specifically note the globalisation considerations of production/operations management decisions as summarised in table 21.1.*
-

16.3 CORPORATE SOCIAL RESPONSIBLE PRODUCTION AND OPERATIONS MANAGEMENT



ACTIVITY 16.2

Study the second section of chapter 21 entitled “Corporate social investment (CSI)” in your prescribed book and then answer and/or complete the following:

- (1) Social responsibility refers to and within the context of production and operations management, it means in decisionmaking.
 - (2) What are the social responsibility issues as far as the following production and operations management decision areas are concerned: product/service design, network design, layout of facilities, process technology, job design, planning and control (including MRP, JIT and project planning and control), capacity planning and control, inventory planning and control, supply chain planning and control, quality planning and control and TQM, and failure prevention and recovery?
-



FEEDBACK: ACTIVITY 16.2

- (1) *Question 1. This question deals with the concept of social responsibility and the impact on production/operations management. Review the discussion by the authors of your prescribed book in chapter 21 and specifically note the impact social responsibility may have on: (a) the organisation's customers/clients; (b) its staff; (c) its suppliers who provide it with materials and services; (d) the community in which the organisation/business operates; and (e) the shareholders and owners who invest their capital in the business.*
 - (2) *Question 2. This question deals with the social responsibilities that production/operations managers have to take into consideration when making decisions. Review the discussion by the authors of your prescribed book in chapter 21 and then study table 21.2.*
-

16.4 ENVIRONMENTAL RESPONSIBLE PRODUCTION AND OPERATIONS MANAGEMENT



ACTIVITY 16.3

Study the third section of chapter 21 entitled “Environmental responsibility” in your prescribed book and then answer and/or complete the following:

- (1) What does production/operations management’s environmental responsibility entail?
- (2) How can the total environmental burden (EB) for an operation be determined? What is the implication for managing the production/operations activity should efforts be planned to reduce the EB?
- (3) What are the environmental responsibility issues as far as the following production and operations management decision areas are concerned: product/service design, network design, layout of facilities, process technology, job design, planning and control (including MRP, JIT and project planning and control), capacity planning and control, inventory planning and control, supply chain planning and control, quality planning and control and TQM, and failure prevention and recovery?

- (4) What does “green reporting” entail and why is it increasingly becoming common among businesses to report on their specific environmental policies and performance?
 - (5) How can the introduction of the ISO 14000 standard contribute to environmental management and what are its specific requirements? Which areas are covered by the ISO 14000 group of standards?
 - (6) Explain the parallel in the organisational role that quality and environmental management are fulfilling in terms of a business.
-



FEEDBACK: ACTIVITY 16.3

- (1) Questions 1 to 3. These questions deal with the concept of environmental responsibility, the determination of the environmental burden and the impact on production/operations management. Review the discussion by the authors of your prescribed book in chapter 21. Also read the case study “Ecological footprints” in chapter 21 of your prescribed book and see if you can calculate South Africa’s (or your own country’s) ecological footprint.
 - (2) Questions 4 to 6. These questions deal with green reporting, ISO 14 000 and the strategic impact similarity between quality and environmental management. Review the discussion by the authors of your prescribed book in chapter 21. Finally, note the critical remarks made by the authors of your prescribed book regarding the similarity of ISO 14 000 and the quality procedures of ISO 9 000 and the need for legislation. Do you agree? Also note that noise pollution is becoming a bigger challenge worldwide. The resulting deaths caused by noise and the noise-induced hearing loss (NIHL) statistics are alarming. Drastic noise control measures need to be taken and the WHO (World Health Organization) has several programmes to address this issue. Best practice hearing conservation is one example and an updated ISO standard to address this issue is expected to be developed/published.
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16.5 TECHNOLOGY-DRIVEN PRODUCTION AND OPERATIONS MANAGEMENT



ACTIVITY 16.4

Study the fourth section of chapter 21 entitled “Technology” in your prescribed book and then answer and/or complete the following:

- (1) Why is technology a major challenge for production/operations management? What are the three implications of technology that make it important as far as production/operations managers are concerned?
 - (2) What are the technological issues for the following production and operations management decision areas: product/service design, network design, layout of facilities, process technology, job design, planning and control (including MRP, JIT and project planning and control), capacity planning and control, inventory planning and control, supply chain planning and control, quality planning and control and TQM, and failure prevention and recovery?
 - (3) What does the concept of “disruptive technologies” include and how does it differ from “sustainable technologies”?
-



FEEDBACK: ACTIVITY 16.4

- (1) Questions 1 and 3. These questions deal with the technology challenge, the implications of technology for production/operations managers and the concept of “disruptive technologies”. Review the discussion by the authors of your prescribed book in chapter 21.
 - (2) Question 2. This question deals with the social responsibilities that production/operations managers have to take into consideration when making decisions. Review the discussion by the authors of your prescribed book in chapter 21 and then study table 21.4.
-

16.6 KNOWLEDGE MANAGEMENT-ORIENTED PRODUCTION AND OPERATIONS MANAGEMENT



ACTIVITY 16.5

Study the fifth section of chapter 21 entitled “Knowledge management” in your prescribed book and then answer and/or complete the following:

- (1) What does the concept of “knowledge management” entail and how does it apply to production/operations management?
 - (2) Describe the distinction which the authors make between data, information and knowledge (in chapter 21 of your prescribed book). Do you agree with them?
 - (3) What are the knowledge management issues for the following production and operations management decision areas: product/service design, network design, layout of facilities, process technology, job design, planning and control (including MRP, JIT and project planning and control), capacity planning and control, inventory planning and control, supply chain planning and control, quality planning and control and TQM, and failure prevention and recovery?
 - (4) What is the difference between “explicit knowledge” and “tacit knowledge” and how do they relate to the production/operations management body of knowledge (POMBOK)?
-



FEEDBACK: ACTIVITY 16.5

- (1) Questions 1, 2 and 4. These questions deal with the knowledge management challenge, the implications of knowledge management for production/operations managers, the difference between data, information and knowledge and explicit versus tacit knowledge. Review the discussion by the authors of your prescribed book in chapter 21. The last two issues are of prime importance and rather contentious at the moment. This is because the “new” merged Unisa (which includes the academic institution of Unisa, the career-oriented training institution of TSA and VUDEC) now has to grapple with its wide range of product offerings and decide how best to perform its primary function of distance learning and teaching.
 - (2) Question 3. This question deals with the knowledge management considerations that production/operations managers have to take into account when making decisions. Review the discussion by the authors of your prescribed book in chapter 21 and then study table 21.5.
-



CHECK LIST

Now that you have completed study unit 16 on the production and operations management challenge, you should be able to do the following:

- Explain the impact of the globalisation of markets, supply bases and the “state-of-mind” of production/operations managers.
- Explain the changing view of the social responsibility which all types of businesses must adopt and the role of production/operations managers in establishing ethical values.
- Explain the environmental responsibility of businesses and the impact that production/operations management decisions may have on the environment and the impact that environmental regulatory frameworks have on production/operations managers.
- Explain the influence of increasingly rapid and difficult-to-predict technology developments on production/operations management.
- Explain the emergence of the concept of “knowledge management” and the production/operations manager as the key custodian of process technology.
- Use your knowledge of, and insight into
 - the globalisation challenge to production and operations management
 - the social responsibility challenge to production and operations management
 - the environmental responsibility challenge to production and operations management
 - the technology development challenge to production and operations management
 - the “knowledge management” challenge to production and operations management

to justify their importance and to demonstrate that you understand this by identifying both correct and incorrect alternative statements based on the study material. You should also be able to do practical applications and answer both multiple-choice and essay-type questions

- Demonstrate your understanding of the production and operations management challenge by explaining the theoretical concepts and demonstrating that you can apply the relevant production and operations skills in practice.



SUMMARY

This study unit examined some of the challenges to production and operations management. As suggested at the beginning of the second-year level module, MNO2601, production and operations management is an exciting and dynamic field of expertise. Even a brief reflection on some of the new challenges and contemporary issues ought to convince you of the importance of production and operations management in the 21st century.



ASSESSMENT

- (1) Read the case study entitled “CSI as it is presented” at the end of chapter 21 in your prescribed book and then answer the questions asked at the end of this case study.
- (2) Complete the study activities at the end of chapter 21 of your prescribed book.

Note: Some study activities may require you to simply reread a portion of the chapter you have just studied, while others may draw on your general knowledge and experiences

of a particular business/organisation. Finally, others may even require you to visit a local business/organisation to investigate an aspect of the subject yourself.

REFLECTION AND CONCLUSION

This third-year level module, which follows our second-year module, MNO2601, once again examined the specialist discipline of production and operations management within the context of a business. It consisted of three major parts: (1) developing production and operations management strategies; (2) some further aspects of designing, planning and controlling the production and operations management system; and (3) improving the production and operations management system.

We hope you enjoyed learning more about production and operations management and that you will be able to use your newly acquired knowledge of and skills in this very important and exciting field of business expertise, not necessarily only as a specialist production and operations manager, but perhaps in whichever business management field you decide to specialise. We wish you everything of the best with your preparations for the examinations and we hope that you will join us as an honours student in ADPRODE (Advanced Operations Management) and PROJEKH (Project Management).