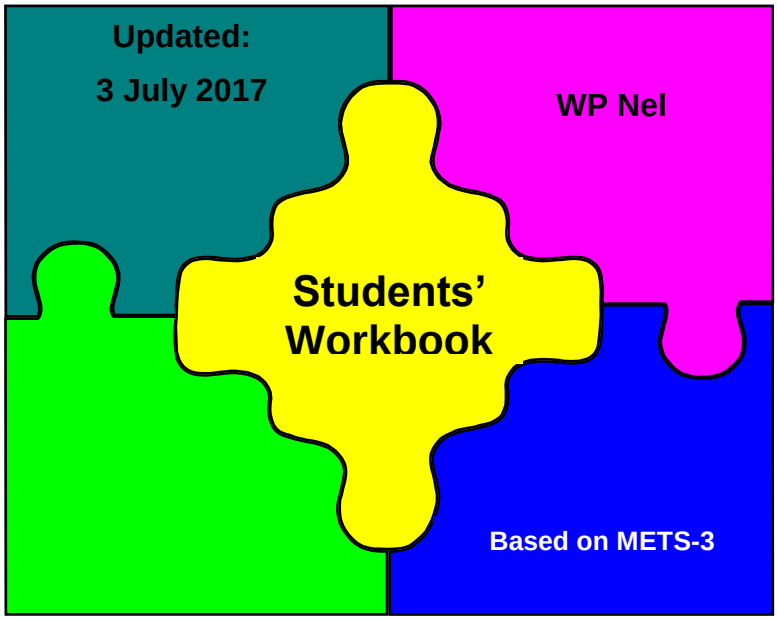
Workbook for students

Chapters 18 – Managing Technology and Innovation



Based on: 'Management for Engineers, Technologists and Scientists' (METS-3)

Chapter 18, Managing Technology and Innovation

Dear reader

Please refer to this workbook as follows:

Nel, W.P. 2017. Workbook for the 3rd edition of "Management for Engineers, Technologists and Scientists": Chapter 18. 8 February 2017.

I suggest that you use this workbook as follows:

- *Study **section 18.1** "**Introduction**" (METS-3: 376-378) from the textbook (METS-3).*
- *Go to section 18A of this workbook and answer the true/false questions from section 18A.1.*
- *Next, go to section 18B of the workbook and attempt all the multiple choice questions from section 18B.1.*
- *Now try to answer all the short and long questions from section 18C.1 of the workbook.*
- *Repeat the above for the different sections of the textbook and workbook – sections 18.2, 18.3, etc.*

I hope that this will help you to master this chapter.

Regards

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Section 18 A – True/false questions

This question consists of true/false questions. State whether the following statements are true or false. In your answer book, write down "true" or "false" and provide a brief explanation for your answer where appropriate.

18A.1 The following **true/false questions** are based on **section 18.1** "**Introduction and the role of innovation**" (METS-3: 376-378) of the textbook.

18A.1.1 Product life cycles have been shortened as a result of greater R&D spending and technological innovation.
Answer: True, (METS-3: 376) (1)

18A.1.2 Technological innovation is an important driver of economic growth.

18A.1.3 Technological innovation can result in the creation of new industries.

18A.2 The following **true/false questions** are based on **section 18.2** "**Defining Technology Management**" (METS-3: 378-382) of the textbook.

18A.2.1 "Innovation" and "invention" are synonyms.

18A.2.2 According to Haour, Innovation is invention converted into a product, an industrial process or a service for the marketplace.

18A.2.3 Basic research is usually based on one of the natural sciences and entails studies that involve the understanding of how the laws of nature regulate the world around us. (1)

18A.2.4 Applied research is usually based on one of the natural sciences and entails studies that involve the understanding of how the laws of nature regulate the world around us. (1)

18A.2.5 The science-push approach to innovation starts with scientific discovery whereas the demand-pull approach starts with the needs of the customer. (1)

18A.2.6 Increasing the memory capacity of a flash memory stick from 4GB to 8GB is an example of radical innovation. (1)

18A.2.7 An electrical rock drill (for hard rock) that replaces the pneumatic (compressed-air) rock drill is an example of a radical innovation. (1)

18A.2.8 The invention and commercialisation of the manufacturing of materials with functionality at a nano-scale is an example of transformational innovation. (1)

18A.3 The following **true/false questions** are based on **section 18.3** "**How technologies and industries evolve**" (METS-3: 383-387) of the textbook.

18A.3.1 Movement along an S-curve takes place because of radical innovation. (1)

18A.3.2 Dominant designs meet the needs of most users. (1)

18A.3.3 The Windows operating system is an example of a dominant design in the personal computer (PC) operating system market. (1)

18A.3.4 As technologies mature, the focus of innovators shifts from product to process innovation. (1)

18A.3.5 The replacement of mechanical watches with quartz watches is an example of a technological discontinuity. (1)

18A.3.6 A technological discontinuity occurs when an old technology is replaced by a new dominant technology. (1)

18A.3.7 The replacement of passenger propeller-driven aircraft by jet engine-driven aircraft is an example of a technological discontinuity. (1)

18A.3.8 The evolution of technology often follows the pattern of an S-curve. (1)

18A.3.9 The improvement in performance of a new technology during the early stages is often slow because the fundamentals may be poorly understood. (1)

18A.3.10 As industries evolve, one would expect components to become more specific to a product. For example, the wheels of the first cars still looked much like those of wagons, but were changed later. (1)

18A.3.11 As industries evolve, one would expect organisational structures to become more rigid and controlled. (1)

18A.3.12 As industries evolve, one would expect competition to shift from being functionality based towards being price based. (1)

18A.4 The following **true/false questions** are based on **section 18.4** "**Technology Strategy**" (METS-3: 387-390) of the textbook.

18A.4.1 Companies that follow a first-to-market strategy have a temporary monopoly. (1)

18A.4.2. The application of engines and power trains by Honda in various products such as motorcycles, lawnmowers, cars, snow equipment and electricity generators is an example of a core competency. (1)

18A.4.3. A fast follower aims to achieve early market entry to the growth phase of the market by imitating the innovation of others. (1)

18A.4.4. One method of sourcing (obtaining) technology is to buy out the essential personnel from a rival firm. (1)

18A.5 The following **true/false questions** are based on **section 18.5** "**The Innovative Organisation**" (METS-3: 390-392) of the textbook.

18A.5.1 The balance between tight and loose, rigid and free is one of the important themes of organisational theory in innovative environments. (1)

18A.5.2 Money invested in innovation may not yield immediate returns. (1)

18A.5.3 Tasks that are unstructured, complex and dynamic are generally best performed in loose organisational structures. (1)

18A.5.4 A champion is a team member in a technologically innovative company that provides the communication channel between members of the team, the rest of the organisation and other organisations. (1)

18A.6 The following **true/false questions** are based on **section 18.6** "**Developing New Products**" (METS-3: 392-395) of the textbook.

18A.6.1 A suggestion scheme is one way of generating ideas for the development of new products. (1)

18A.6.2 Motorcycle enthusiasts that modify standard models to obtain additional performance are examples of lead users. (1)

18A.6.3 A product portfolio is the collection of current products, product enhancements and future products that a company is currently marketing or intends to market. (1)

18A.6.4 (Technology) portfolio balance is about the balance between high-risk and low-risk types of projects. (1)

18A.7 The following **true/false questions** are based on **section 18.7** "**Managing Knowledge and Intellectual Property**" (METS-3: 395-397) of the textbook.

18A.7.1 The appropriability problem deals with the problem of how innovators can protect their innovations and enjoy the benefits of the money that can be generated from such intellectual property. (1)

18A.7.2 Patenting is the only mechanism for protecting intellectual property. (1)

18A.7.3 Tacit knowledge is the knowledge embedded in the people and the processes in the company that is difficult to codify and to transfer to others. (1)

18B.1 The following **multiple choice questions** are based on **section 18.1** "**Introduction and the role of innovation**" (METS-3: 376-378) of the textbook.

18B.1.1 Read the following three statements:

a) Product life cycles have been shortened as a result of greater R&D spending and technological innovation.

b) Technological innovation is an important driver of economic growth.

c) Technological innovation can result in the creation of new industries.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a and b

[4] a and c

[5] None of the options (1, 2, 3, or 4) is correct.

Answer 18B.1.1: [1]

a) True, (METS-3: 376)

b) True, (METS-3: 377)

c) True, (METS-3: 378)

18B.2 The following **multiple choice questions** are based on **section 18.2** "**Defining Technology Management**" (METS-3: 378-382) of the textbook.

18B.2.1 Read the following three statements:

a) "Innovation" and "invention" are synonyms.

b) According to Haour, Innovation is invention converted into a product, an industrial process or a service for the marketplace.

c) Basic research is usually based on one of the natural sciences and entails studies that involve the understanding of how the laws of nature regulate the world around us.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a and b

[4] a and c

[5] None of the options (1, 2, 3, or 4) is correct.

18B.2.2 Read the following three statements:

a) Applied research is usually based on one of the natural sciences and entails studies that involve the understanding of how the laws of nature regulate the world around us.

b) The science-push approach to innovation starts with scientific discovery whereas the demand-pull approach starts with the needs of the customer.

c) Increasing the memory capacity of a flash memory stick from 4GB to 8GB is an example of radical innovation.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a and b

[4] a and c

[5] None of the options (1, 2, 3, or 4) is correct.

18B.3 The following **multiple choice questions** are based on **section 18.3** "**How technologies and industries evolve**" (METS-3: 383-387) of the textbook.

18B.3.1 Read the following three statements:

a) Dominant designs meet the needs of most users.

b) The Windows operating system is an example of a dominant design in the PC operating system market.

c) Movement along an S-curve takes place because of radical innovation.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] a and b

[3] b and c

[4] a and c

[5] None of the options (1, 2, 3, or 4) is correct.

18B.3.2 As industries evolve, one would expect …

a) components to become more specific to a product. For example, the wheels of the first motorcars still looked much like those of wagons, but were changed later.

b) organisational structures to become more rigid and controlled.

c) competition to shift from being functionality based towards being price based.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a

[4] a and b

[5] None of the options (1, 2, 3, or 4) is correct.

18B.3.3 Read the following three statements:

a) The replacement of mechanical watches with quartz watches is an example of a technological discontinuity.

b) A technological discontinuity occurs when an old technology is replaced by a new dominant technology.

c) The replacement of passenger propeller-driven aircraft by jet engine-driven aircraft is an example of a technological discontinuity.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a

[4] a and b

[5] None of the options (1, 2, 3, or 4) is correct.

18B.4 The following **multiple choice questions** are based on **section 18.4** "**Technology Strategy**" (METS-3: 387-390) of the textbook.

18B.4.1 Read the following three statements:

a) Companies that follow a first-to-market strategy have a temporary monopoly.

b) A fast follower aims to achieve early market entry to the growth phase of the market by imitating the innovation of others.

c) One method of sourcing (obtaining) technology is to buy out the essential personnel from a rival firm.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a

[4] a and b

[5] None of the options (1, 2, 3, or 4) is correct.

18B.5 The following **multiple choice questions** are based on **section 18.5** "**The Innovative Organisation**" (METS-3: 390-392) of the textbook.

18B.5.1 Read the following three statements:

a) The balance between tight and loose, rigid and free is one of the important themes of organisational theory in innovative environments.

b) Tasks that are unstructured, complex and dynamic are generally best performed in rigid organisational structures.

c) A champion is a team member in a technologically innovative company that provides the communication channel between members of the team, the rest of the organisation and other organisations.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a

[4] a and b

[5] None of the options (1, 2, 3, or 4) is correct.

18B.6 The following **multiple choice questions** are based on **section 18.6** "**Developing New Products**" (METS-3: 392-395) of the textbook.

18B.6.1 Read the following three statements:

a) A suggestion scheme is one way of generating ideas for the development of new products.

b) A product portfolio is the collection of current products, product enhancements and future products that a company is currently marketing or intends to market.

c) (Technology) portfolio balance is about the balance between high-risk and low-risk types of projects.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a

[4] a and c

[5] None of the options (1, 2, 3, or 4) is correct.

18B.7 The following **multiple choice questions** are based on **section 18.7** "**Managing Knowledge and Intellectual Property**" (METS-3: 395-397) of the textbook.

18B.7.1 Read the following three statements:

a) The appropriability problem deals with the problem of how innovators can protect their innovations and enjoy the benefits of the money that can be generated from such intellectual property.

b) Patenting is the only mechanism for protecting intellectual property.

c) Tacit knowledge is the knowledge embedded in the people and the processes in the company that is difficult to codify and to transfer to others.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a

[4] a and c

[5] None of the options (1, 2, 3, or 4) is correct.

18B.8 The following **multiple choice questions** are based on **Chapter 18,** "**Managing Technology and Innovation**" (METS-3: 376-397) of the textbook.

18B.8.1 Read the following four statements:

a) The application of engines and power trains by Honda in various products such as motorcycles, lawnmowers, cars, snow equipment and electricity generators is an example of a core technology.

b) Tasks that are unstructured, complex and dynamic are generally best performed in loose organisational structures.

c) Motorcycle enthusiasts that modify standard models to obtain additional performance are examples of lead users.

d) The “appropriability problem” deals with the problem of how innovators can protect their innovations and enjoy the benefits of the money that can be generated from such intellectual property.

Which of the above statements is/are **correct**? (2)

[1] a, b, c and d

[2] b, c and d

[3] b and c

[4] c and d

[5] none (not a, b or c)

18B.8.2 Read the following three statements:

a) The evolution of technology often follows the pattern of an S-curve.

b) The improvement in performance of a new technology during the early stages is often slow because the fundamentals may be poorly understood.

c) Applied research is usually based on one of the natural sciences and involves studies that involve the understanding of how the laws of nature regulate the world around us.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] a

[4] a and b

[5] a and c

18B.8.3 Read the following three statements:

a) Patenting is the only mechanism for protecting intellectual property.

b) (Technology) portfolio balance is about the balance between high-risk and low-risk types of projects.

c) Dominant designs meet the needs of most users.

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] b and c

[3] b

[4] c

[5] a and c

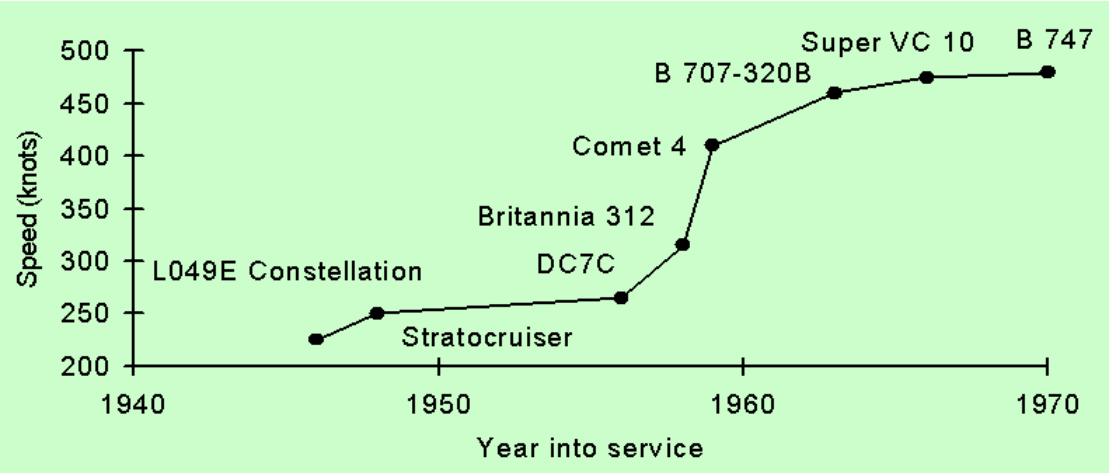
18B.8.4 Which one of the statements below is **incorrect**? (2)

[1] In order to be adopted, technology must be compatible with the values, norms and experience of consumers.

[2] A fast follower aims to achieve early market entry to the growth phase of the market by imitating the innovation of others.

[3] A champion is a team member in a technologically innovative company that provides the communication channel between members of the team, the rest of the organisation and other organisations.

Figure 1 - The top speeds of a number of aircraft have been plotted on the graph below.



{Please note: 1 knot = 1,852 km/h; and Mach 1 is about 1 225 km/h at sea level.}

18B.8.5 Read the following three statements:

a) Figure 1 is an example of a Foster S-curve.

b) The physical constraint in this example is that of the speed of sound (Mach 1).

c) The graph illustrates that engineering effort were invested in improving the speed of aircraft in the 1950s and 1960s.

d) It took a while for engineers in the late 1940s and early 1950s to improve the speed of aircraft

Which of the above statements is/are **correct**? (2)

[1] a, b and c

[2] a, c and d

[3] a, b, c and d

[4] c and d

[5] a and d

18B.8.6 Read the following three statements:

a) Increasing the memory capacity of a flash memory stick from 4GB to 8GB is an example of radical innovation.

b) Radical innovation usually makes the competencies in old technology obsolete.

c) Product innovation will result in an improved process.

Which of the above statements is/are **correct**? (2)

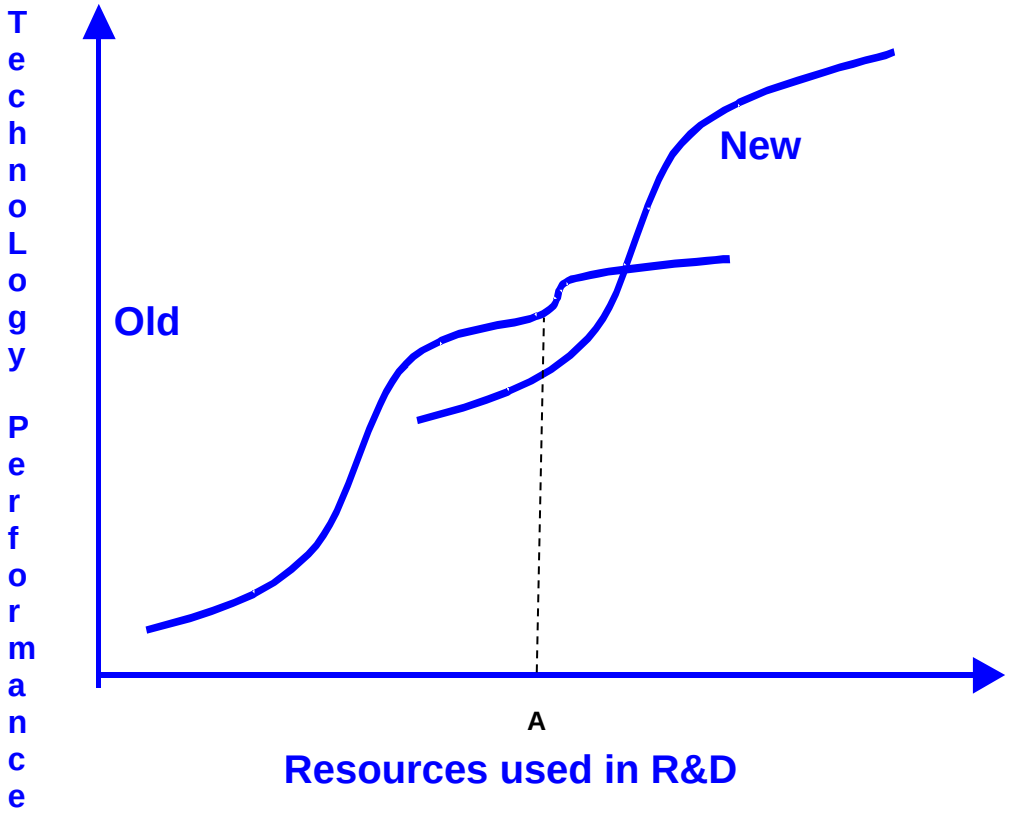
[1] a and c

[2] a and b

[3] a, b and c

[4] b and c

[5] b



18B.8.7 Read the following three statements regarding the above figure:

a) The above are known as the Foster, S-curves of the old and new technologies.

b) "Time", measured in years for example, can be used as an x-axis variable in some curves of this nature instead of "resources used in R&D".

c) The old technology's performance is still superior at point A (compared to the new technology).

Which of the above statements is/are **correct**? (2)

[1] a and c

[2] a and b

[3] a, b and c

[4] b and c

[5] a

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Section 18C – short and long questions

18C.1 The following **short and long questions** are based on **section 18.1** "**Introduction and the role of innovation**" (METS-3: 376-378) of the textbook.

Question 18C.1.1

Briefly explain why technological innovation is important for businesses and the economy? (5)

18C.2 The following **short and long questions** are based on **section 18.2** "**Defining Technology Management**" (METS-3: 378-382) of the textbook.

Question 18C.2.1

Briefly differentiate between innovation and invention. (2)

Question 18C.2.2

Differentiate between product innovation, process innovation and service innovation AND give examples of each type of innovation. Draw the following table in your answer book and fill in the missing information:

Innovation type	**Function/Definition**	**Example**
Incremental		
Radical		
Product		
Process		
Service		

(10)

Question 18C.2.3

Define technology management. (2)

Question 18C.2.4 (Innovation cycle)

List and briefly describe the components of the innovation cycle.

Or

Describe the (linear) process of innovation - from the point of basic research to where a new product or service is successfully introduced in the market.

Or

Choose an appropriate example of an innovation [for example 1) E-commerce via the Internet or 2) Nano-technology*] and demonstrates the innovation cycle by means of the development of this example of innovation from basic research to the successful introduction of the product or service in the market. (10)

* The word nano-technology was used for the first time in 1974 by Taniquchi in a paper

(Source: A Short History of Nanotechnology – https://www.foresight.org/nano/history.html)

Question 18C.2.5

Differentiate between product innovation, process innovation and service innovation AND give examples of each type of innovation. (6)

Question 18C.2.6 – The innovation process

Mini case study: The evolution of human body scanning technology

Background information

In the second half of the 1800s, many entrepreneurs who obtained the rights to claims (small pieces of land) started to mine diamonds in Kimberley, South Africa. Many of these claims were next to one another on a kimberlite pipe that had been formed when molten magma and diamonds were pushed from deeper down to the earth's surface. Each claim was usually mined by small teams of workers. At times the diggings of adjacent claims were at different depths giving rise to safety and other practical problems. This is probably one of the reasons why claim holders were willing to sell their claims to larger companies such as De Beers who combined the small claims to mine kimberlite pipes on a large scale.

One problem that the large companies experienced was that of diamond theft. Rather than handing diamonds to their supervisors, some miners and mine workers sold diamonds to diamond traders for their own benefit. The large companies introduced searches of employees after each shift as a result of this, but these employees became more innovative

in hiding diamonds by, for example, hiding them in the soles of their shoes. The situation escalated further; strip searches were introduced, resulting in the first strike by white diamond miners in 1883 and the swallowing of diamonds by some employees (Bezuidenhout, 2016:17). It is clear that a better, more dignified method was required to search employees.

In 1895 X-rays were discovered by Wilhelm Roentgen while he was working with a cathode ray tube in his laboratory. It took a number of years after this discovery before X-ray machines were developed and adopted by the medical profession. By the 1930s X-ray machines were central to hospital diagnosis (www.sciencemuseum.org.uk).

Please read the short article below.

Article - **SA company designing, manufacturing 'unrivalled' digital X-ray scanner**

South African medical engineering group Lodox Systems will release the fourth version of its digital X-ray screening technology, dubbed the Xmplar-dr, which the company says is "unrivalled" as the world's only high-speed full-body digital scanning device.

Originally developed in the 1990s as a security device to prevent the theft of diamonds by workers at mining giant De Beers' operations, the scanner was later adapted for use in medical trauma management to provide an almost instant diagnostic image of a patient's injuries.

Earlier versions of the scanner, which is fully locally designed and manufactured, are currently in operation at over 40 healthcare institutions worldwide, including at the Chris Hani Baragwanath hospital, in Soweto, and Inselspital Bern, in Switzerland.

Lodox CEO Pieter de Beer explained that the exceptional feature of the Xmplar-dr is that it takes only 13 seconds to produce an accurate full-body overview of injuries and foreign bodies in a patient, as opposed to a conventional X-ray machine, which requires several minutes and various individual X-rays to compile a full-body image.

The technology employs a proprietary linear X-ray beam, which produces fewer harmful scattered X-ray photons than a conventional wide-beam system, while generating an inherently higher image quality and resolution.

In addition, the device emits a radiation dose of 0.12 milligray – up to ten times less radiation than a conventional X-ray system.

“No other device can provide clinicians with such a fast and accurate picture of a patient’s entire body, in combination with such a low radiation dose, which means that the device can be used directly in emergency rooms, without the need for a separate X-ray unit,” he told *Engineering News Online*.

He added that in forensic pathology environments, the Lodox technology provides a user-friendly, high-speed method of assessing a subject’s entire body, in multiple planes, to assist with pathology location, and is particularly useful in determining the location of bullets in gunshot victims.

This eliminates the need to move the subject to obtain the required view from several angles.

“In trauma settings, the scanner also permits easy access to the patient to allow monitoring and resuscitation to take place in conjunction with the scanning process, which is impossible with a conventional X-ray process,” said De Beer.

While the group’s primary healthcare markets were the medical trauma, medico-legal and medico-forensic sectors, applications for the scanner beyond these disciplines were being investigated, including its use in paediatric and bariatric medicine.

Commenting on the value of the scanner, De Beer said Lodox instituted varied pricing structures for the local public healthcare market, the local private healthcare market and the international healthcare sector.

“As a subsidiary of development financier, the Industrial Development Corporation, which is our 95% shareholder, we want to keep the machine as cost effective as possible so that it is accessible for the South African public healthcare sector. As such, the local selling price to public hospitals is around R4-million, while the cost increases to up to R5-million for the international market,” he commented.

Currently producing around 24 scanners a year, the group said it aimed to have a scanner in all local tertiary hospitals, as well as most district hospitals, in the next two to three years.

“We expect to sell between 14 and 16 machines in the next year and to align current production capacity with demand in the year thereafter,” said De Beer.

The Lodox Xmplar-dr scanner was featured on season nine, episode 18 of US medical drama series Grey’s Anatomy.

(Source: Engineering News Online)

Required:

i) List the different stages of the linear, "science push" model of the innovation process. (5)

ii) Apply the linear, science push model of innovation to the development and commercialisation of the Lodox Xmplar-dr scanner where possible. Mention some of the criticisms against the linear model. Explain if the development and commercialisation of the Lodox Xmplar-dr scanner conform fully to the linear model of the innovation process. You may develop your own model to explain the nature of the innovation process as illustrated in this or other case studies. (10)

References

Bezuidenhout, A. 2016. Stryd met diep wortels. Beeld, 6 December: 17.

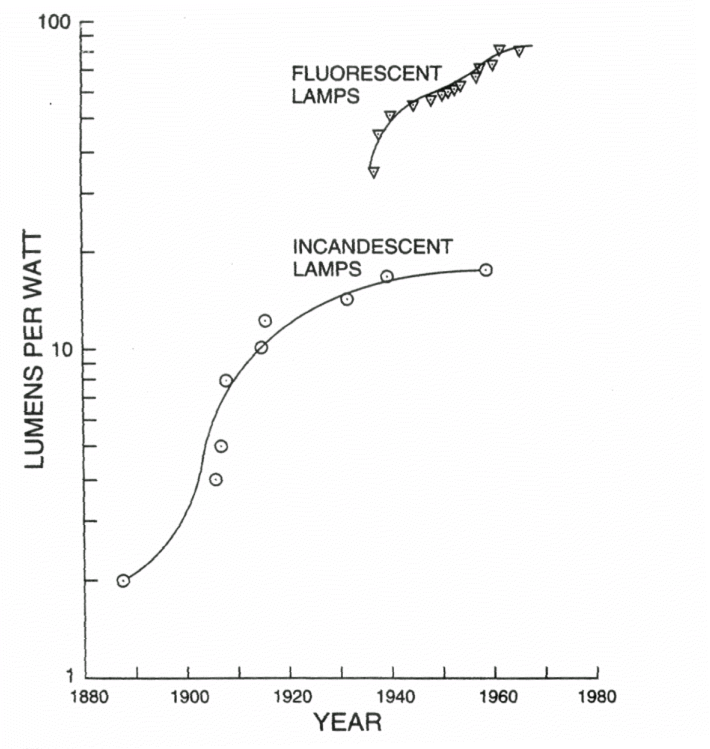
Greve, N. 2013. SA company designing, manufacturing 'unrivalled' digital X-ray scanner. Available at: http://www.engineeringnews.co.za/article/sa-company-designing-manufacturing-unrivalled-digital-x-ray-scanner-2013-06-10 (accessed on 12/06/2

[15]

18C.3 The following **short and long questions** are based on **section 18.3** "**How technologies and industries evolve**" (METS-3: 383-387) of the textbook.

Question 18C.3.1

Study the graph below. What is a graph like this generally called? Explain why technology may generally evolve along the lines indicated below. The graph serves as an example of a technological discontinuity. Discuss the consequences of technological discontinuity for companies producing incandescent lamps. (8)



Question 18C.3.2

Briefly explain how a Foster "S-curve' is constructed. Explain why the evolution of technology may follow such a pattern. You may use an example to explain your answer. You will earn one mark for including a graphical illustration. (4)

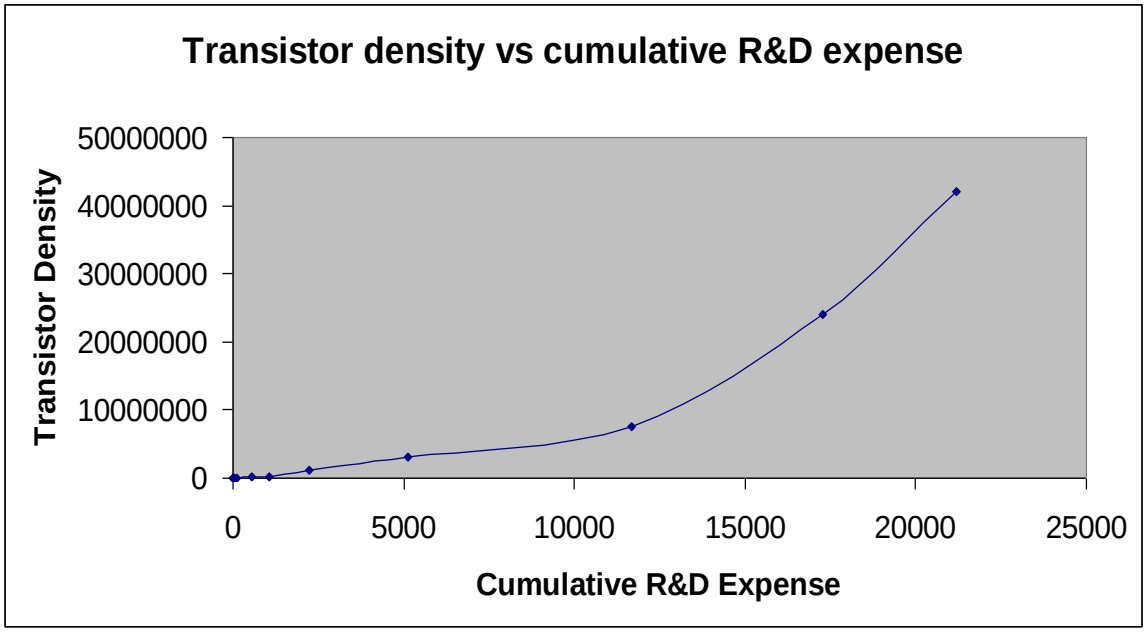
Question 18C.3.3

Briefly describe how industries generally change from their early (young) stages to mature industries in the following areas: manufacturing processes, components, nature of competition, organisational structures and industry structure. Complete the following table: (10)

Evolution of …	**When industry is young**	**When industry is mature**
Manufacturing process		
Components		
Nature of competition		
Organisational structures		
Industry structure		

Question 18C.3.4

Study the graph below and answer the questions:



i) What type of graph is this (in general)? {1}

ii) Predict how this graph may continue in the future and explain why. {2}

(3)

Or

Briefly explain how a Foster "S-curve' is constructed. Explain why the evolution of technology may follow such a pattern. (4)

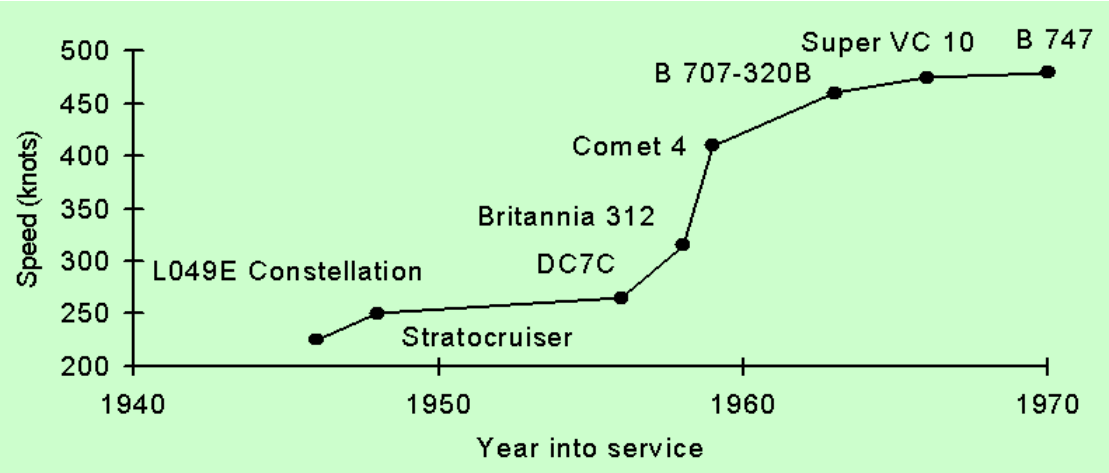
Question 18C.3.5

Give an example of a technological discontinuity and illustrate its consequences for established companies. (3)

Question 18C.3.6

The top speeds of a number of aircraft have been plotted on the graph below. What are such graphs generally called? Explain why the evolution of technology may generally follow such a pattern. Also explain the shape of the pattern for this specific example. (5)

{Please note: 1 knot = 1,852 km/h; and Mach 1 is about 1 225 km/h at sea level.}



Question 18C.3.7

Explain why the model T Ford has become a collector's item. Why is it no longer mass produced? (1)


The model T Ford

18C.4 The following **short and long questions** are based on **section 18.4** "**Technology Strategy**" (METS-3: 387-390) of the textbook.

Question 18C.4.1

Briefly describe the fast-follower technology strategy and give an example. (2)

Question 18C.4.2

A. List at least four methods of sourcing (obtaining) technology and briefly evaluate each method. (8)

B. You are the Research and Development (R&D) Manager at a large pharmaceutical company. In addition to managing R&D internally you also have the responsibility of sourcing technologies from outside the company. List at least four such methods of

improving and expanding the company's current core competencies and technology portfolio. (8)

C. Provide at least one example of the following methods for the sourcing of technology:

* Develop internally
* Licensing
* Joint venture (3)

Question 18C.4.3

Briefly discuss any five of the following six aspects of technology strategy listed below: (10)

- Timing of market entry
- Technology portfolio
- Level of expertise in each technology
- Sourcing of technology
- Level of investment in R&D
- Organisation policies and practices supporting a work environment that encourages innovation

18C.5 The following **short and long questions** are based on **section 18.5** "**The Innovative Organisation**" (METS-3: 390-392) of the textbook.

Question 18C.5.1

Match each one of the following critical roles in a technologically innovative company with the appropriate description thereof. In your answer book, write down the number of each term, and next to it the letter representing the correct option, for example, "1. f". (5)

1. Idea generator		a. A person who promotes an idea enthusiastically.
2. Champion		b. A person who provides the communication channel between members of the team, the rest of the organisation and other organisations.
3. Project leader		c. A creative person who is generally an expert in his/her field and enjoys solving problems.
4. Gatekeeper		d. A senior person who can guide a project through organisational politics.
5. Sponsor		e. A pragmatist who focuses on planning and making decisions to get the job done.

Question 18C.5.2 (Innovative organisational environment)

List ten organisational factors that support the creation and maintenance of an innovative organisational environment. (10)

Or

You are the manager of the research and development department at an organisation. Briefly explain how you would create and maintain an innovative environment for your subordinates to work in. (5)

18C.6 The following **short and long questions** are based on **section 18.6** "**Developing New Products**" (METS-3: 392-395) of the textbook.

Question 18C.6.1

List five sources of idea generation when developing a new product. (5)

Question 18C.6.2

Discuss (technology) portfolio management by referring to strategic alignment, portfolio balance and resource requirements. (6)

18B.7 The following **short and long questions** are based on **section 18.7** "**Managing Knowledge and Intellectual Property**" (METS-3: 395-397) of the textbook.

Question 18C.7.1

List (and discuss?) a number of (statutory and non-statutory) mechanisms that a firm (or individual) can use for protecting intellectual property. (12)

18C.8 The following **short and long questions** are based on **Chapter 18,** "**Managing Technology and Innovation**" (METS-3: 376-397) of the textbook.

Question 18C.8.1

Explain what your current employer, or another company that you are familiar with can do to improve innovation. (6)

Question 18C.8.2

Describe one area where innovation is required for the mining or energy industry (or a specific mining company) to grow or to survive. Some information/ideas can be obtained from:

- http://deepmine.csir.co.za?
- Deep Sea exploration of oil – up to 3 km
- Further developments in mineral processing equipment
- Technology needed to reduce pollution
- Better exploration techniques
- Improved underground communication and information gathering
- Generation of its own electricity
- Increased mechanisation and automation

Question 18C.8.3

A number of car manufacturers have built concept fuel-cell cars (fuel cell vehicle – FCV). According to Wikipedia, Hyundai's ix35 FCEV and Toyota's Mirai are the first two limited commercial releases of FCVs (https://en.wikipedia.org/wiki/Fuel_cel_vehicle Accessed on 6 Aug 2015).

Apply your knowledge of the requirements of a new product and your knowledge of the factors that assist the diffusion of a new technology in the market place to specify some characteristics that such a vehicle will need so that it can compete with traditional (internal combustion engine-driven) cars. You may include supporting infrastructure such as fuel distribution in your analysis. Evaluate the ix35 and Mirai in terms of these criteria. (12)

Please note that the underlying theory to the answer is covered in two chapters, namely 11 and 18. Relevant theory: Ch 18 – (METS-3: 392-393); Ch 11 – (METS-3: 242)

Question 18C.8.4

Match each of the following terms on the left of the table with its correct definition, description or example on the right of the table below. In your answer book, write down the number of each term, and next to it the letter representing the correct option, e.g. 1. z. (6)

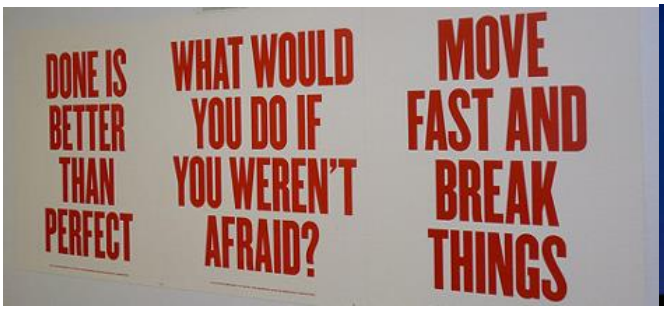
1. Basic research		a. Usually involves the understanding of how the laws of nature regulate the world around us.
2. Incremental product innovation		b. Meets most of the users' needs.

3. Dominant design		c. Automatic teller machines (ATMs) replacing some human tellers at banks.
4. Service innovation		d. Small improvements are made.
5. Core competency		e. This can be protected by means of patents, copyright, registered designs and trademarks.
6. Intellectual property		f. Knowledge, patents and skills regarding engines and power trains can help a company to produce various products (e.g. automobiles, motorcycles, lawnmowers, snow equipment and electricity generators) where that can be used.

Question 18C.8.5

In a competitive business environment where new products and services constantly have to be developed and introduced to the market, it is important for employees to work fast, especially if they want to be and stay the market leader. In such a work environment employees will often be forgiven for making mistakes and they are expected to learn and develop themselves continuously. The culture in such a work environment is characterised by various mottos and slogans, for example:

"Innovate or evaporate" (Haour, 2004: 1)
"Move fast and break things" Facebook's Mark Zuckerberg
"Done is better than perfect" Facebook's Mark Zuckerberg



Source:
http://www.freemake.com/blog/mark-zuckerberg-quotes-8-remarkable-sayings-of-facebook-ceo/

Required:

a) Briefly add to the characteristics (already mentioned) of the fast-moving, very competitive and innovative business environment. (4)

b) Do you think this culture (that is to be found among Silicon Valley companies) is also applicable to the motor industry where the safety of a car is an important characteristic (or the producers of devices and components used in mine hoisting systems or the construction industry or the nuclear power generation industry)? (2)

[6]

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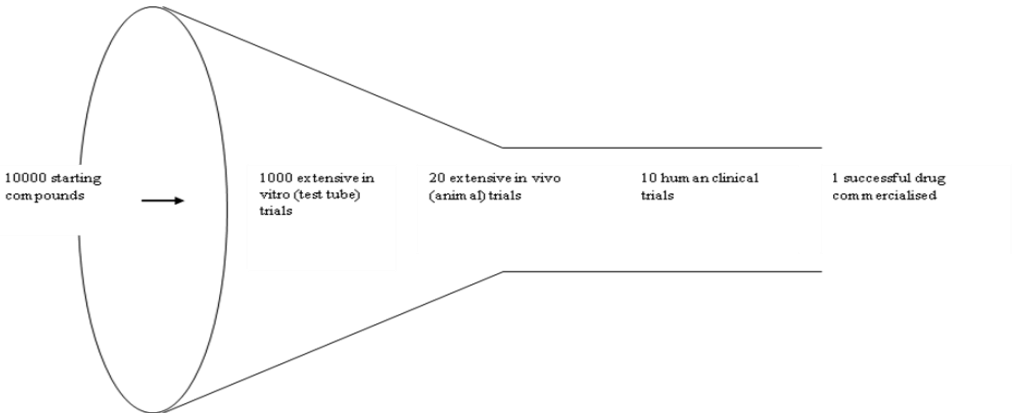
Section 18D – Project work

Note: You will find general guidelines for the answering of projects and the writing of reports in Annexure C, at the end of this document.

Project 18D.1 [Management of Innovation at a specific organisation or industry]

Write a report on the management of innovation at an organisation that you know well. You may refer to one or more of the following aspects related to the management of innovation:

- How does the company generate or obtain new ideas, innovation and technology? (Does it buy it, develop it [through its own RD&D], or obtain it from collaborative networks and joint venture partners? See fig 17.5, METS-2:380)
- Provide a short description of some of the projects/innovations in this organisation's "innovation funnel". (See example of the innovation funnel for the pharmaceutical industry below.)



- Describe the management of the technology/innovation portfolio.
- Identify the core technologies of this organisation.
- Describe the management of organisational structure, creativity and talent – creating the right organisational climate for innovation
- How are the necessary capacity for technical competencies/capabilities for innovation developed?

- How is the translation from creativity to innovation managed?
- How are the collaborative networks (eg strategic alliances, JV partners, licensing arrangements, outsourcing of production, etc) managed?
- How is the timing of market entry managed?
- What is the technology strategy of this organisation?
- Which distinctive technological competences and capabilities are necessary to establish and maintain competitive advantage?
- Which technologies should be used to implement core product design concepts and how should these technologies be embodied in products?
- What should the investment level in technology development be?
- How should various technologies be sourced: internally or externally?
- When and how should new technology be introduced to the market?
- How should technology and innovation be organised and managed?
- How are innovation projects selected (or chosen) by this organisation?
- How does this organisation protect its intellectual capital/property (patents, trademarks, copyrights, keeping it secret)?
- How is the management of new product development and teams executed?
- Is this organisation benefitting optimally from its intellectual property?
- What is this organisation's capacity to do technology forecasting?
- Benchmark this organisation's competencies and technologies against that of its competitors.
- Scanning the environment and. Does this organisation scan the environment for new technologies that are in the process of being developed elsewhere and what is their absorptive capacity?
- Does it have the capacity to evaluate the impact of such technologies on its core business processes and future competitive environment?

Project 18D.2 [New product development]

The purpose of innovation is to develop new products, services or processes. This mini-project should therefore contain many of the elements in question 18D.1

The development of new products and services that are well received by the market can do wonders for a company. Just consider how Apple's share price has improved under Steve Jobs' leadership since 1997. Since then Apple has developed the iMac, iPod, iPad, MacBook

Pro, new iMac with Intel processors, iPhone and opened the online iTunes store and App Store.

Describe the new product development process at your company or a company that you are familiar with. Alternatively you may write a case study on the development of a specific product, service or process. Remember that the focus should not be on technical aspects (e.g. how the product works) but on the new production development process, the commercialisation thereof – the whole process of taking the new invention to the market and making money from it.

The following are good examples of products to write such a case study on:

1. Detnet's products – see http://www.electronicinitiation.com
2. The Xmplar-dr, digital X-ray scanner – see http://www.engineeringnews.co.za/article/sa-company-designing-manufacturing-unrivalled-digital-x-ray-scanner-2013-07-04

Project 18D.3 [Managing a specific innovation]

Select an innovation and describe the influence of this innovation on the industry or relevant company(ies). A list of examples follow:

- The development of the Hilti electric (hard) rock drill
- Sasol's gas to liquids (GTL) and Coal to liquids (CTL) processes:
  - Petrol from coal processes – see http://www.sasol.com/sasolprocesses/
  - Diesel from natural gas – see http://www.sasol.com/sasolprocesses/
- Mintek's miniature process as applied at Harmony Gold
- The Joint Venture (JV) between AngloGold Ashanti and De Beers to use marine mining technology to explore for and mine marine deposits off the continental shelf. (See: Faurie J, 30 October 2009, Miners eye sea as land resources diminish, *Mining Weekly Online* - http://www.miningweekly.com)
- MineCorex and Midrex processes, Saldanha Steel
- Billiton's (Gencor) bio-technological processes
- The possibility of using DebTech's (research and development arm of De Beers) full body scanning technology (originally developed to detect diamonds on miners) at airports. (See: Pringle C, 5 Jan 2010, De Beers scanning technology could be used at airports. *Engineering News Online* - http://www.engineeringnews.co.za)

- Sasol Coal's adaptation of a standard oil drilling technique to obtain better geological information in coalfields – see *SA Mining, Coal, Gold & Base Minerals*, October 1992, p.15

Explain whether this innovation provides the company with a competitive advantage over its competitors or not. Explain the advantages and disadvantages of being the first to market with an invention. Describe the process the company has to go through from having an idea to the point where it is successfully introduced into the market. In other words, you must explain the innovation process by referring to relevant theory and use at least one innovation model to explain the innovation process at this company. You may also include some of the issues mentioned in 18D.2. If possible choose a relevant innovation (eg minerals industry related innovation if you are are enrolled for a programme in mining engineering).

If you selected an innovation that has not yet been commercialised (taken to the market), then determine the following:

- Technical/technology feasibility: How soon will the technology be ready for the market?
- Economic viability: Will the investment in R&D be recouped?

Project 18D.4 [Technology audit]

Do a technology audit on an organisation that you have access to. Identify the core competencies or technologies of this organisation.

Project 18D.5 [Technology forecasting]

Briefly describe one or more of the following technology forecasting techniques and then apply it to one or more technologies/technological innovations. The emphasis should be on application.

- Expert judgement
- Delphi technique
- Trend extrapolation
- Normative forecasting
- Forecasting by monitoring
- Dynamic modelling
- Scenarios

- Learning curve/experience curve

Project 18D.6 [Patenting and the management of intellectual property: patent procedure + pros and cons of patenting]

Produce a report that will tell an inventor exactly what procedure to follow when registering a patent in South Africa (or any other country of your choice). You must also explain the potential advantages and disadvantages of patents from both the perspective of patent holders and society in general. You must explain the following in your report:

- What can be patented?
- What are the advantages and possible disadvantages of patenting? What is patent trolling?
- What protection will patenting in a specific country provide to the inventor?

The document must include details such as where patents must be registered (address), costs and requirements of the patent office. You should earn higher marks if you interviewed at least one person or representative of a company who is benefitting from a patent and another individual or representative from a company who is disadvantaged by existing patents.

Project 18D.7 [Innovation trajectory – technology S-curve]

Draw an S-curve (or curves) for a product or technology for which you can obtain the data. You must attach the data to your assignment and analyse the S-curve that you obtained. For example, give reasons for the shape of the S-curve. You should preferably provide your data in spread sheet format (eg Microsoft Excel) and use the graphics facilities of the software application to draw the S-curve. Attach as much information as possible to your assignment (preferably in electronic format). Possible examples of S-curves follow (this is just to give you a better idea of what is required):

- Drilling rate (eg metres per minute) of underground hard rock drilling machines on the vertical axis versus time and/or engineering effort on the horizontal axis. What will the S-curves for two different technologies (air-driven machines and hydro-powered machines) tell us in this case?
- Power produced by a 1500cc internal combustion (car) engine on the vertical axis versus time and/or engineering effort on the horizontal axis.

- The number of transistors that can be placed per cm^2 of silicon wafer on the vertical axis versus time and/or engineering effort on the horizontal axis.
- Laser or ink-jet printer speed (measured in characters or pixels per second) on the vertical axis versus time and/or engineering effort on the horizontal axis. What will the S-curves for two different technologies (laser and ink-jet) tell us in this case?

You can obtain more information on S-curves from a number of books, including the following readings in Burgelman, RA, Maidique, MA & Wheelwright, SC. 2000. *Strategic management of technology and innovation*. 3rd edition. Boston: McGraw-Hill/Irwin:

- Reading II-4A (pp 124–142): Christensen, CM. 1992. Exploring the technology S-curve. Part I: component technologies.
- Reading II-4B (pp 142–149): Christensen, CM. 1992. Exploring the technology S-curve. Part II: architectural technologies.

Project 18D.8 [Solving the appropriability problem]

Identify a number of individuals or/and organisations (e.g. companies) who developed unique products, software, games, manufacturing methods, mining methods, business methods, product names, designs and/or books (called "intellectual property"). Describe in detail for each of the cases identified by you, how the company has solved the appropriability problem. In other words, which non-statutory mechanisms and/or statutory mechanisms are they using to protect their intellectual property. (For background information, read pp. 395-397 of METS-3).

Evaluate each of the choices that these individuals or/and organisations made. In other words, do you think the persons and companies have chosen the most appropriate mechanism/method for protecting their intellectual property. You have to motivate your choices/opinions.

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Section 18E – Case studies

Case 18E.1 (Advent Corporation)

The following questions are based on the Advent Corporation case study written by R.S. Rosenbloom (Harvard Business School Case 9-674-027)).

You will find this case in the following book:

Burgelman, R.A., Christensen, C.M. & Wheelwright, S.C. 2009, 5th ed. Strategic Management of Technology and Innovation, McGraw-Hill, Case I-2, pp. 49-62

Note: This case study is about a small company called Advent Corporation and its owner, Mr Kloss, in the 1970s.

1. Describe Advent's strengths and weaknesses. Describe its initial business and technology strategy. Explain whether Advent has a "first-to-market" or "fast follower" marketing strategy and how that impacts on its technology strategy. (12)

2. Discuss the value chain of Advent and indicate which skills, capabilities and technologies are used in it. (6)

3. The following organisational factors support the creation and maintenance of an innovative organisational environment:

   - Vision, leadership and will to innovate
   - Appropriate structure
   - Key individuals
   - Effective teamwork
   - Innovative climate
   - Learning organisation
   - Customer focus

   Describe Kloss' general management task of exploiting Advent's capacity for innovation. Use the above factors to evaluate Kloss' role as a general manager. (10)

4. The process of innovation can be described by various models. According to the linear model, the innovation process consists of the following steps:

   - Basic research
   - Applied research
   - Product idea generation

- Product and/or process development
- Market entry

Use the above model to describe the innovation process at Advent and the role of Kloss. (6)

5. The paper by Madique and Hayes, "The Art of High-Technology Management", refers to factors that make high-tech companies successful. Use this reading and other frameworks to explain what Kloss could still do to improve innovation at Advent. (4)

6. What resources are required to develop the full screen television? (4)

7. What options are available to Kloss? Describe the pros and cons of each option and make a recommendation on what Advent should do. You must incorporate the technology portfolio model in your answer. (8)

[50]

Additional sources of information:

Madique, M.A. & Hayes, R.H., 1984 The Art of High Technology Management, Sloan Management Review 25 (Winter 1984), pp. 18-31

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Case 18E.2 (Eli Lilly and Company: Drug Development Strategy)

The following questions are based on the Eli Lilly case study written by S. Thomke, A. Nimgade & P. Pospisil (Copyright: Harvard College).

You will find this case in the following book:

Burgelman, R.A., Christensen, C.M. & Wheelwright, S.C. 2009, 5th ed. Strategic Management of Technology and Innovation, McGraw-Hill, Case II-8, pp. 470-485

1. Discuss Eli Lilly's technology strategy. You may want to refer to the following:
    - timing of market entry;
    - technology portfolio;
    - level of expertise in each technology;
    - sourcing of technology;
    - level of investment in Research and Development; and

- organisational policies and practices. (15)

2. Describe some of the competitive challenges that pharmaceutical companies face in the 1990s (and beyond). What are the resulting implications for the new drug development process? (6)

3. Technology strategy involves choices between alternative technologies. Briefly describe how combinatorial chemistry is changing the drug discovery process. How does it affect the roles of experience and experimentation? What are its risks? How does combinatorial chemistry affect the different stakeholders in the development process (e.g. traditional chemists, research scientists, middle and senior management)? (8)

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Case 18E.3 (Intel Corporation (D): Microprocessors at the Crossroads)

The following questions are based on the Intel Corporation case study written by D. Steer & R.A. Burgelmann.

You will find this case in the following book:
Burgelman, R.A., Madique, M.A. & Wheelwright, S.C. 1996, 2nd ed. Strategic Management of Technology and Innovation, McGraw-Hill, Case II-15, pp. 455-478

Case II-15 (pp.455-478), Intel Corporation: Microprocessors at the crossroads

1. In what phase of the industry life cycle (ILC) is the CISC technology? What would you say is the reason why the financial characteristics in that specific ILC phase are different from the usual reasons? Why should or shouldn't Intel proactively propose RISC technology as the new architecture to power Personal Computers? Use the industry life cycle model to explain your answer. (10)

2. Intel faces a challenge from RISC and from within the x86 architecture. Discuss both challenges critically to determine where the greatest threat to Intel lies. What other threats is Intel also facing? (8)

3. Discuss Intel's strategy with the original equipment manufacturers (OEMs) and their relationships with end-users. Which of these two groups does Intel seem to view as its

key customers? How should Intel react towards these interest groups? What is the role of the corporate marketing group? What is Intel's marketing strategy? How well is it integrated with the technology strategy? How well is it integrated with the micro-processor business strategy? (9)

4. How important is Microsoft for Intel's microprocessor business strategy? Why? What is the role of software in Intel's microprocessor business strategy? (6)

5. How important is manufacturing capability and know-how in Intel's technology strategy for microprocessors? Explain your answer. (4)

6. Suppose you were AMD. How would you feel about Intel? Why? What would you try to do? How would you do it? (5)

7. What should Intel's competitive strategy for its older microprocessor generations be? Why? (4)

8. How dependent is Intel's corporate strategy on microprocessors? What should it do about that? (4)

[50]

Section 18F – Sources on the world wide web

18F.1 Do a google search to obtain information on "What can be patented".

18F.2 How did Robert William Kearns get the idea of an intermittent windshield wiper system? How did his patent of this system protect his intellectual property? What was his patent infringement case against Ford Motor Company all about? Do you think Kearns' innovation is novel / original / new?

18F.3 Read: "Why patents are still central to innovation, whatever Tesla does". Available online at http://www.polity.org.za/article/why-patents-are-still-central-to-innovation-whatever-tesla-does-2014-06-23

18F.4Listen to this audio clip about “Patent trolling” at
http://www.thisamericanlife.org/play_full.php?play=441

18F.5 Find some information about the “New Product Development Process”.

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Section 18G – Reading list for mining students: Managing Technology and Innovation in the Minerals Industry

Bartos, P.J. 2007. Is mining a high-tech industry? Investigations into innovation and productivity advance. *Resources Policy*, 32, 149-158.

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