Pearson BTEC Levels 5 Higher Nationals in Engineering (RQF)

Unit 35:
Professional Engineering Management

Unit Workbook 1

in a series of 1 for this unit

Learning Outcome LO1 to LO4

Professional Engineering Management

4 INTRODUCTION TO ENGINEERING MANAGEMENT

Engineering is the application of scientific knowledge and mathematical methods to practical purposes of the design, construction or operation of structures, machines, or systems. The discipline of engineering encompasses a range of more specialized fields of engineering, each with a more specific emphasis on particular areas of applied mathematics, applied science, and types of application. The term engineering is derived from the Latin *ingenium,* meaning "cleverness" and *ingeniare*, meaning "to contrive, devise".

In the engineering design process, engineers apply mathematics and sciences such as physics to find novel solutions to problems or to improve existing solutions. More than ever, engineers are now required to have a proficient knowledge of relevant sciences for their design projects. As a result, many engineers continue to learn new material throughout their career.

If multiple solutions exist, engineers weigh each design choice based on their merit and choose the solution that best matches the requirements. The crucial and unique task of the engineer is to identify, understand, and interpret the constraints on a design in order to yield a successful result. It is generally insufficient to build a technically successful product, rather, it must also meet further requirements.

Constraints may include available resources, physical, imaginative or technical limitations, flexibility for future modifications and additions, and other factors, such as requirements for cost, safety, marketability, productivity, and serviceability. By understanding the constraints, engineers derive specifications for the limits within which a viable object or system may be produced and operated.

4.1 Problem Solving

Engineers use their knowledge of science, mathematics, logic, economics, and appropriate experience or tacit knowledge to find suitable solutions to a problem. Creating an appropriate mathematical model of a problem often allows them to analyse it (sometimes definitively), and to test potential solutions.

Usually, multiple reasonable solutions exist, so engineers must evaluate the different design choices on their merits and choose the solution that best meets their requirements. Engineers typically attempt to predict how well their designs will perform to their specifications prior to full-scale production. They use, among other things: prototypes, scale models, simulations, destructive tests, non-destructive tests, and stress tests. Testing ensures that products will perform as expected.

Engineers take on the responsibility of producing designs that will perform as well as expected and will not cause unintended harm to the public at large. Engineers typically include a factor of safety in their designs to reduce the risk of unexpected failure. However, the greater the safety factor, the less efficient the design may be, as well as being more expensive.

The study of failed products is known as forensic engineering and can help the product designer in evaluating his or her design in the light of real conditions. The discipline is of greatest value after disasters, such as bridge collapses, when careful analysis is needed to establish the cause or causes of the failure.

4.2 Social Context

The engineering profession engages in a wide range of activities, from large collaboration at the societal level, and also smaller individual projects. Almost all engineering projects are obligated to some sort of financing agency: a company, a set of investors, or a government. The few types of engineering that are minimally constrained by such issues are pro bono engineering and open-design engineering.

By its very nature engineering has interconnections with society, culture and human behaviour. Every product or construction used by modern society is influenced by engineering. The results of engineering activity influence changes to the environment, society and economies, and its application brings with it a responsibility and public safety.

Engineering projects can be subject to controversy. Examples from different engineering disciplines include the development of nuclear weapons, the design and use of sport utility vehicles and the extraction of oil. In response, some western engineering companies have enacted serious corporate and social responsibility policies.

Engineering is a key driver of innovation and human development. Sub-Saharan Africa, in particular, has a very small engineering capacity which results in many African nations being unable to develop crucial infrastructure without outside aid

All overseas development and relief NGOs make considerable use of engineers to apply solutions in disaster and development scenarios. A number of charitable organisations aim to use engineering directly for the good of mankind:

- Engineers Without Borders
- Engineers Against Poverty
- Registered Engineers for Disaster Relief
- Engineers for a Sustainable World
- Engineering for Change
- Engineering Ministries International

Engineering companies in many established economies are facing significant challenges with regard to the number of professional engineers being trained, compared with the number retiring. This problem is very prominent in the UK where engineering has a poor image and low status. There are many negative economic and political issues that this can cause, as well as ethical issues. It is widely agreed that the engineering profession faces an "image crisis", rather than it being fundamentally an unattractive career. In this regard, much work is needed to avoid a numbers crisis in the UK and other western economies.

4.3 Code of ethics

Many engineering societies have established codes of practice and codes of ethics to guide members and inform the public at large. The National Society of Professional Engineers code of ethics states:

> *Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity. Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behaviour that requires adherence to the highest principles of ethical conduct.*

4.4 Making it work: Engineering Project Management

Project management has evolved to plan, coordinate and control the complex and diverse activities of modern industrial, IT, commercial and management change. All projects share one common characteristic; the projection of ideas and activities into new endeavours. The ever-present element of risk and uncertainty means that the events and tasks leading to completion can never be foretold with absolute accuracy. Examples abound of projects that have exceeded their costs by enormous amounts, finishing late or even being abandoned before completion. Such failures are far too common, seen in all kinds of projects in industry, commerce and especially, it seems, the public sector.

The purpose of project management is to foresee or predict as many of the dangers and problems as possible and to plan, organize and control activities so that projects are completed successfully in spite of all the risks. This process should start well before any resource is committed and must continue until all work is finished. The primary aim of the project manager is for the result to satisfy the project sponsor or purchaser and all the other principal stakeholders, within the promised timescale and without using more money and other resources than those that were originally set aside or budgeted.

Of course, the aim of a project manager must be to achieve success in all aspects of the project. But it is occasionally necessary to identify one of the three primary objectives, that is, cost, performance (includes quality), and time, as being of special importance. This emphasis can affect the priority given to the allocation of scarce resources and the way in which management attention is concentrated. It can also influence the choice of project organisation structure.

5 WHO's WHO

We need to be clear about some of the terms we're going to use, especially when it comes to the responsibilities carried by the people involved. Mainly, a project will be organised between three principal parties; Customer, Contractor, and End-user. A few simplified examples are provided in FIG XXX to illustrate that project relationships can extend well beyond the customer-contractor boundaries.

Project Type	***Project example***	***Project customer***	***Principal 'contractor'***	***End user***	***Operated and maintained by:***
1 Civil engineering, construction, petrochemical, mining and quarrying	Local authority housing development	Local authority	Wimply	Housing tenants	Local authority
	Private toll road	Landowner	Tarpack	Road users	Landowner's agent
	Copper mine	Cupric Ltd	Cupric Ltd (head office engineering)	Cupric (Zambia) Ltd	Cupric (Zambia) Ltd
2 Manufacturing	New passenger aircraft	Going Ltd	Going Ltd	Various airlines	Various airlines
	Automatic rifle	Ministry of Defence	Small Arms Ltd	Military units	Military units
	Washing machine development	Hotwash Ltd	Hotwash R&D dept	Domestic users	Domestic users
3 Management	Design and implement new sales procedures	ABC Ltd	ABC Ltd (with external consultant)	ABC staff	ABC Ltd
	Office relocation	Greens of London	Greens' (internal task force)	Greens of Exeter	Greens of Exeter
4 Research	Speculative research for new plastic materials	Chemikl Ltd	Chemikl Ltd (laboratory)	Unknown	Not applicable

Figure 1 Examples of Project Relationships

1. **Customer**: The person or organisation for which the project is being conducted. In this context *client* and *project owner* are loosely synonymous. The project customer is traditionally a person or organisation that pays another organisation money in return for a project. However, in many management change projects the company is, in effect, both customer and contractor, with the board or senior management of the company acting as the customer, whilst the manager or department instructed to carry out the project assumes the role of contractor.
2. **Contractor:** The organisation that is principally responsible for executing the project work to the customer's requirements. It is not restricted to its more common use as used in the contracting industry for construction projects. So, contractor describes any organisation or group that carries out a project, whether or not the project is carried out against a formal sales contract.
3. **End user:** The individual or organisation that will ultimately own and operate the project. This is not always the same person or organisation that paid for the original project. Consider, for example, a research and development project carried out by the Whitewash Company PLC to develop washing machines for sale in the retail sector. The customer for this project would be Whitewash PLC, the main

contractor would be the design engineering department of Whitewash PLC, and members of the public who bought the machines would be the end users.