Unit 7: Business Operations in Engineering

Unit code: R/600/0257

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit gives learners an understanding of the major factors that affect the way that engineering companies operate in competitive business environments. They will also develop skills in costing techniques for engineering activities.

Unit introduction

Engineers are employed in a range of businesses within the primary, secondary and tertiary sectors. Their knowledge and skills are used to carry out a variety of specific functions that solve the needs of businesses and contribute to their commercial success. By making effective use of their engineers' expertise, organisations can secure competitive advantage, whether they be a small owner-managed company or a large limited company with many shareholders.

For anyone considering a career in engineering, it is important to have an understanding of how an engineering business operates and its position within society. This unit will develop learners' understanding of business, the engineering industry and the effect of engineering on the environment. It will help give learners a firm foundation for employment in the engineering sector and an understanding of the organisational, financial, legal, social and environmental constraints within which an engineering company operates.

The unit will enable learners to examine an engineering company in detail. This could be either the one in which they are employed or one in an engineering sector in which they may look for employment. Learners will understand how the company operates, the factors that impact upon the business and the importance of a cost-effective output. This will include an examination of the engineering functions of the company and the importance of communication and information flow within the business. This is set within a study of how external factors and the economic environment impact on the company.

Learners will examine relevant legislation and how it can place considerable constraints on the way that a typical engineering company is required to operate. A company cannot survive if it is not profitable and the unit allows learners to consider the use and implication of costing techniques on the sustainability of a particular engineering activity.

Learning outcomes

On completion of this unit a learner should:

1 Understand how an engineering company operates

2 Understand how external factors and the economic environment can affect the operation of an engineering company

3 Know how legislation, regulation and other constraints impact on the operation of engineering businesses

4 Be able to apply costing techniques to determine the cost effectiveness of an engineering activity.

Unit content

1 Understand how an engineering company operates

Sectors: primary eg oil, gas, agriculture; secondary eg chemical, manufacturing, automotive, aerospace, marine, sports; tertiary eg energy distribution, nuclear technologies, waste management, water services, building services, civil, construction, structural, health, telecommunications

Engineering functions: eg research and development (R&D), design, manufacture, materials supply and control, production planning and control, installation, commissioning, maintenance, technical support, technical sales, project planning and management, quality assurance

Organisational types: size eg micro, small, medium, large; status eg sole trader, partnership, public (plc), private (ltd), new, established, charitable, not for profit; structure eg owner-manager, boards, committees, governors, hierarchical, flat, matrix

Information flow: internal systems eg lines of communication, working procedures, e-systems, integrated systems; people involved eg supervisor, other employees, customers, suppliers; types of information eg work instructions (such as operation sheets, engineering drawings, circuit diagrams), work in progress records, stock/orders/sales; work ethics of communication eg confidentiality, integrity, respect

2 Understand how external factors and the economic environment can affect the operation of an engineering company

External factors: factors to consider eg markets, consumers, demographic and social trends, competitive products/services/organisations, customer/client relationships, innovation and technological change, availability of sustainable resources

Economic environment: measures eg gross national product (GNP), gross domestic product (GDP), balance of payments; location eg local economy, regional and national economy (such as Regional Development Agency, local/regional skills targets); economic variables eg interest rates, exchange rates

3 Know how legislation, regulation and other constraints impact on the operation of engineering businesses

Legislation: legislation eg Health and Safety at Work Act 1974, Employment Act 2002, Factories Act 1961, Fire Precautions Act 1971, Data Protection Act 1998, Companies Act 2006

Regulation: eg Employment Equality (Age) Regulations 2006, Management of Health and Safety at Work Regulations 1999, Provision and use of Work Equipment Regulations 1998, Control of Substances Hazardous to Health (COSHH) Regulations 2002, Lifting Operations and Lifting Equipment Regulations 1998, Manual Handling Operations Regulations 1992, Personal Protective Equipment at Work Regulations 1992, Confined Spaces Regulations 1997, Electricity at Work Regulations 1989, Noise at Work Regulations 1989, Reportable Injuries Diseases and Dangerous Occurrences Regulations 1998, Working Time Regulations 1998, Workplace (Health, Safety and Welfare) Regulations 1992, Health and Safety (First Aid) Regulations 1981

Environmental constraints: eg sustainability, environmental impact, use of renewable energy resources, carbon footprint, recycling, product end of life strategy

Social constraints: eg employment levels, workforce skill levels and training requirements, opportunities for self improvement and progression, motivation, impact of outsourcing

4 Be able to apply costing techniques to determine the cost effectiveness of an engineering activity

Costing techniques: income; expenditure; profit/loss; cost control eg direct cost, indirect cost, fixed cost, variable cost, contribution, marginal costing; assets eg investment and value of fixed assets, depreciation of fixed assets

Make-or-buy decisions: eg break-even point, investment appraisal, return on investment, pay-back time, financial risk, development costs

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 describe the different sectors in which engineering companies operate and the function that they carry out in that sector [SM2]	**M1** explain how improvements in information flow could enhance the functional activities of an engineering company	**D1** evaluate the information flow through an engineering company in relation to an engineering activity
P2 describe the organisational types of three given engineering companies	**M2** discuss the impact of legislation on a specific operation within a typical engineering company in terms of benefits and limitations	**D2** evaluate the importance and possible effect of the external factors that directly impact on an engineering company.
P3 outline how information flows through an engineering company in relation to an engineering activity	**M3** demonstrate how the cost effectiveness of an engineering activity could be improved.	
P4 explain how external factors and the economic environment affect the way in which an engineering company operates		
P5 identify the legislation and regulations that impact on the way an engineering business operates		
P6 describe the environmental and social constraints that impact on the way an engineering business operates		
P7 carry out costing techniques to determine the cost effectiveness of an engineering activity		
P8 carry out costing techniques to reach a make-or-buy decision for a given product. [IE4]		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

The unit as a whole provides an opportunity for investigative, relevant and active study that will develop learners' understanding of the factors that affect the ways in which engineering companies operate. The unit will underpin further study of the principles and processes of engineering and will provide an appreciation of the sector. Learners are likely to achieve better if this unit is delivered in the latter half of the course to allow mature knowledge about engineering and manufacturing to be considered and used.

The four learning outcomes are strongly linked and the delivery strategy should ensure that these links are emphasised. Learners need to gain a coherent view of business systems within an engineering context. This includes knowing about the operation of engineering companies, the factors that impact upon them (for example economic and legislative), and the financial implications of being in business. This final aspect is vital to a business if it is to survive and grow.

The focus of delivery will be very much dependent on the centre's ability to access engineering business organisations. Ideally, centres will have industry links through their learners' employer(s) but, if the course is full time, for learners who are not yet employed this could be through work placements. Alternatively, delivery could be achieved through case studies of local engineering companies that may provide employment opportunities for learners. It is likely that a case study approach would need to be supported by a range of industry visits to enable learners to put the size and scope of engineering as an industry into perspective.

Industry visits, even for learners who are in full-time employment, should form an important part of the unit's delivery strategy. Seeing a variety of engineering companies will provide learners with a much greater appreciation of the diverse nature of the different engineering sectors. This appreciation should include an understanding that engineering is virtually everywhere and not just limited to the more conventional forms of manufacturing often depicted in the media. It could be reinforced by making it clear how, for example, learners' own music systems are 'engineered' or how the building in which they are studying relies on engineering: the overall structure of the building, its structural materials, the equipment it contains and its maintenance.

The methods of delivery should be, as far as possible, activity based. The learning activities could make use of case studies, researching actual engineering businesses and industry visits. Examples of case studies could include examining structures of engineering organisations, information systems, historical views of changing economic and social environments, the impact of legislation and regulations on a specific engineering company. If learners are employed then it could be useful for them to research aspects of their own company and make comparisons with other industries. For example, a learner working in a small limited company, with only five or six staff, could examine how the business functions of larger organisations (R&D, design, maintenance, technical sales etc) are carried out or vice versa.

Activities could also be set around video footage, with learners reviewing a programme (for example on current affairs such as the impact of outsourcing and the global economy or business improvement). Groups of learners could then prepare a presentation (for example poster, formal presentation) of their findings in terms of the engineering functions and information flow.

Tutors could also use role play, gaming or modelling to good effect. A suitably designed modelling exercise relating to the manufacture of a product would cover all the functions carried out by a business, for example design, cost calculations, compliance with legislation, sales, etc.

The ultimate purpose of the delivery strategy must be to provide learners with as wide an experience as possible of engineering business functions. If learners are to be able to work in a truly independent way but also interdependently within an organisation then this can only come about through a sound understanding of the principles of how engineering companies operate.

Centres will need to carefully consider when this unit is to be delivered within the programme of learning. To be truly effective, the unit requires learners to have an appreciation of the core aspects of the engineering (for example manufacturing/production processes) and the language of engineering. This is because they will be exposed to these concepts very quickly as they begin to examine the functions of engineering companies.

Note that the use of 'eg' in the content is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'eg' needs to be taught or assessed.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Whole-class teaching: • introduction to the unit and learning outcomes • introduction to the concept that to survive in the global marketplace a business must be well-managed and operate according to statutory codes of practice • describe engineering sectors – primary, secondary and tertiary. *Small-group research using case studies*: • functions carried out within engineering businesses – R&D, design, manufacture, sales etc • types of organisation – SME, large, plc etc • types of management structure – hierarchical, flat, matrix etc. *Tutor-led matching card game*: • sector, company, type of organisation, management structure. *Presentation by visiting engineer*: • an overview of how their company operates. *Individual activity*: • prepare a brief report about the speaker's company.
Whole-class teaching: • information flow within a business and the way that this process is managed effectively. *Small-group research based on case studies*: • lines of communication • job roles and their interaction with information flow • communication techniques – drawings, worksheet, paper based, 'e' systems, integrated systems.
Individual activity: • preparation for a company visit – research data about the business eg product range, number of employees, turnover, history etc • industrial visit to a local, regional or national engineering company. (It may be more appropriate to use a number of shorter highly focused visits- this will depend on logistical factors). *Small-group working*: • produce reports about the visit- information presented should relate just to topics investigated in this unit.

Topic and suggested assignments/activities and/assessment
Preparation for and carry out **Assignment 1: Types and Operation of Engineering Businesses** (P1, P2, P3, M1, D1).
Whole-class teaching: • introduce the concept that the profitability of a company is influenced by the marketplace into which it sells and the prevailing/future economic climate. *Small-group research*: • external factors – the relationships between markets, customers, competition and technological change • the effect that external factors have on the profitability of businesses • innovation and change • economic environment – GNP, GDP, balance of payments, interest rates, local and national economy • regional Development Agencies • review case study material. *Small/whole group activity*: • present overview of research findings to whole group using PowerPoint.
Whole-class teaching: • explain why businesses have a duty of care towards their employees, suppliers, customers and anyone else that they have a relationship with. *Small-group or pair working*: • research health and safety legislation specific to the operation/management of an engineering business • explore the ways in which business operations in the UK are regulated by legislation and standards. Contrast this with manufacturing in low-wage economies in other parts of the world.
Pair working: • prepare for a presentation by a speaker from local industry – research data about the speaker and their company eg job role, number of employees, legislation specific to the business. *Presentation by visiting engineer*: • legislation and regulations which impact on the operation of the business. Detailed information about how the business complies at a 'shop floor' level is not required – learners need data about the company strategy for implementing, monitoring and auditing compliance with legislation. *Small-group working*: • produce reports on what was presented by the speaker.
Whole-class teaching: • environmental and social constraints • operating in an ethical and responsible way in order to maintain share in a marketplace where customers are becoming ever more concerned about the environment and labour conditions • employment levels • skill levels, training, motivation • the impact of outsourcing.
Preparation for and carry out **Assignment 2: External Factors, Legislation and Constraints which Affect the Operation of an Engineering Company** (P4, P5, P6, M2, D2).

Topic and suggested assignments/activities and/assessment
Whole-class teaching: • explore the concept that if a business is to be profitable it must have effective cost and management accounting systems. *Pair working*: • carry out a cost analysis of an engineering product using standard techniques. • investigate how businesses carry out forward planning using mathematical modelling • investment appraisal and the evaluation of different options • deciding whether to make a product or sub-contract the manufacture (make-or-buy decisions). *Small-group working and role play*: • investment appraisal for a given product – each group to present their findings to the whole group using PowerPoint. Tutor adopts the role of finance director of an engineering business and leads a discussion about which presentation to 'accept'.
Preparation for and carry out **Assignment 3: Assessing the Cost and Viability of an Engineering Activity** (P7, P8, M3).
Review of unit delivery and assessment.

Assessment

It is likely that the assessment evidence for pass criteria P1 and P2 could be produced through the study of three separate engineering companies. One of these could be the company in which the learner is employed, with the others through case study or relevant research of companies chosen either by the learner or the tutor. It is important to ensure an opportunity for activity in all three sectors is given collectively across the three companies studied. Evidence for criteria P3, P4, P5 and P6 could be produced through the study of a single engineering company, again likely to be one chosen by the learner. The remaining pass criteria (P7 and P8) lend themselves to a controlled and time-constrained activity. Although opportunities to carry out costing exercises in a real environment may be used, it may be that issues of business confidentiality will prevent this.

This unit could be assessed using three assignments. The first assignment could assess criteria P1, P2 and P3 together with M1 and D1. Information should be given about three separate engineering companies, real or fictitious, ideally one from each sector (primary, secondary and tertiary). The functions that the companies carry out can be simplified, such as designing a solution to an engineering problem or installing a machine. Other information should be given about the size and structure of the organisations.

Work-based learners may wish to use their own company to satisfy part of each criteria, although they will need data on a further two organisations to fulfil the criteria. Written tasks could be given and the evidence is also likely to be in written format.

For P2, sketches may also help to describe organisational structures. For P3, learners need to be able to explain how functions within a business are able to communicate effectively to support business strategies in relation to an engineering activity (for example the link between design and technical sales, manufacturing and material/component supply). This will link to the content section on information flow, where learners need to describe the internal systems, people involved, types of information and work ethics of communication relevant to a specific activity within an engineering company.

A second assignment should require learners to investigate how external factors and the economic environment (P4); legislation and regulations (P5); environmental and social constraints (P6) impact on the overall operation of an engineering business. It is sensible to also include criteria M2 and D2 in this assignment.

The evidence for the last two pass criteria (P7 and P8) could be gathered through a third assignment involving a costing exercise based on the engineering activity considered in P3. For example, this could involve the use of costing techniques to determine the cost effectiveness of the product/service and then looking at a make or buy decision for part of or the whole product/service. If this is not realistic or appropriate then separate tasks may be necessary. The engineering activity considered in the criteria P3 and P7 could, for example, be the manufacture of a product or the provision of a service. In either case, centres need to ensure that the relevant data is available to cover all aspects of the content, although the product or service itself does not need to be overly complex. A task could then be set to complete a make or buy decision (P8). Criterion M3 is also best linked to this assignment.

To achieve a merit grade, learners will need to apply evaluative skills to explain how improvements in information flow could enhance the functional activities of an engineering company (M1). This could be a natural extension to work carried out for P1, P2 and P3. Learners should also be able to discuss the impact of legislation on a specific operation within a typical engineering company (M2). This has a link with the criterion P5, which considers legislation in a broader context for the company. For merit, learners need to be able to analytically apply the understanding they have gained at pass level to consider the impact of legislation in terms of benefit (for example reduced risk to employees and therefore improved safety record) and limitations (for example increase in production cycle times and therefore increased costs) for the operation considered. Finally, to achieve the last merit criterion M3, learners should be able to consider the costing exercise carried out for P7 and P8 and explain how the cost effectiveness of the engineering activity could be improved or the make-or-buy decision made more conclusive or even amended.

To achieve a distinction grade, learners should be able to focus on a specific activity and evaluate the information flow through an engineering company in support of it (D1). This links to P2 and P3, where learners described organisational types and explained the information flow for an activity and with M1 their ability to consider improvements. The evaluation for D1 should consider the key aspects of the information flow, how it impacts upon the specific activity and other functional activities of the company, plus any issues in terms of problems encountered or opportunities for improvement. As such this could be within the first assignment. To achieve D2 learners should be able to evaluate the importance and possible effects of the external factors that directly impact on an engineering company. Learners will need to be able to use their general understanding of external factors from P4 but at this level begin to take an analytical view of the relative importance and the direct effects on the business.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1, D1	Types and Operation of Engineering Businesses	An activity requiring learners to carry out research based on actual engineering companies. These companies will be involved in a range of business activities, and have different management structures and operating methods.	A portfolio containing written responses and flow diagrams based on primary and secondary research data. Carried out under controlled conditions. This activity could be supported by a PowerPoint presentation.
P4, P5, P6, M2, D2	External Factors and Legislation which Affect the Operation of an Engineering Company	An activity to investigate the external factors and pressures which can affect the profitability of businesses. It involves finding out about economic, legislative and environmental constraints in the context of a given engineering company.	A portfolio containing written responses to a number of defined activities. Carried out under controlled conditions. This activity could be supported by a PowerPoint presentation. This assessment could be delivered in two parts – small group research activity followed by a summative test.
P7, P8, M3	Assessing the Cost and Viability of an Engineering Activity	An investigative activity involving calculation and decision making supported by reflective writing and, where appropriate, verbal presentation.	A portfolio containing spreadsheets and written commentary carried out under controlled conditions. This activity could be supported by a PowerPoint presentation.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Engineering sector suite. This unit has particular links with the following unit titles in the Engineering suite:

Level 1	Level 2	Level 3
		Engineering Design
		Commercial Aspects of Engineering Organisations

This unit can contribute knowledge and understanding towards the Level 3 NVQ in Business Improvement Techniques, Unit 1: Complying with statutory regulations and organisational safety.

Essential resources

Learners require access to sufficient data on engineering companies. This can be in the form of case studies, industry visits or data available through learners' employers.

Employer engagement and vocational contexts

This unit should be delivered and assessed in a vocational context. Much of the investigative activity can be set in the context of learners' work placements supported by case studies of local employers and well known national companies. Learning outcomes 1 and 3 lend themselves well to input from visiting speakers from local engineering businesses. Additional input from a representative of an organisation such as a business enterprise agency or a manufacturers' association will add value to the delivery of the unit.

There are a range of organisations that may be able help centres engage and involve local employers in the delivery of this unit, for example:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI, University of Warwick) – www.warwick.ac.uk/wie/cei
- Learning and Skills Network – www.vocationallearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk
- Work-based learning guidance – www.aimhighersw.ac.uk/wbl.htm

Indicative reading for learners

Textbooks

Boyce A, Cooke E, Jones R and Weatherill B – *BTEC Level 3 National Engineering Student Book* (Pearson, 2010) ISBN 9781846907241

Boyce A, Cooke E, Jones R and Weatherill B – *BTEC Level 3 National Engineering Teaching Resource Pack* (Pearson, 2010) ISBN 9781846907265

Chelsom J, Reavill L and Payne A – *Management for Engineers, Scientists and Technologists, Second Edition* (John Wiley and Sons Ltd, 2004) ISBN 0470021268

Nicholas J and Steyn M – *Project Management for Business and Engineering and Technology* (Butterworth-Heinemann, 2008) ISBN 0750683996

Tooley M and Dingle L – *BTEC National Engineering* (Newnes, 2007) ISBN 0750651660

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	using, analysing and evaluating data to influence a make-or-buy decision
Self-managers	showing initiative and perseverance when identifying engineering sectors, companies and business/engineering functions.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	explaining the impact of legislation on a specific operation within a typical engineering company in terms of benefits and limitations evaluating the information flow through an engineering company in relation to an engineering activity
Team workers	collaborating with others to find, collate and present information about how information flows through a business
Effective participators	carrying out costing techniques to determine the cost effectiveness of an engineering activity.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching data about: • engineering sectors • businesses • the economic environment • legislation and regulations
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	preparing written reports which contain images making and presenting a PowerPoint presentation carry out costing calculations
Mathematics	
Identify the situation or problem and the mathematical methods needed to tackle it	carrying out recognised costing techniques used to determine the cost effectiveness of engineering activities carrying out recognised costing techniques to inform make-or-buy decision making
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	identifying regulations which impact on the way that engineering businesses operate identifying social constraints which impact on the way that engineering businesses operate
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing the engineering functions which companies carry out describing the organisational structures of engineering companies describing environmental constraints which impact on the way that engineering businesses operate.