Unit 3: Engineering Project

NQF level 3: BTEC National

Guided learning hours: 120

Unit abstract

Engineers often find themselves in situations where problems need to be recognised and solutions found. These situations frequently lead to engineers being confronted and challenged by exciting opportunities and problems. Working on 'projects' gives the engineer an opportunity to demonstrate what they know and put their skills to valuable use.

This unit will provide learners with opportunities to present their own solutions and should enable them to feel confident in carrying out project work in their chosen engineering discipline.

The unit is designed so it can be applied to any of the engineering disciplines within the suite of BTEC National qualifications. It aims to integrate the skills and knowledge learners have gained throughout the programme of study into a major piece of work that reflects the type of performance expected of an engineering technician at work.

The project could be chosen by learners with sufficient guidance from the centre to establish an appropriate level of study. Alternatively the project could be given to learners by the tutor. The project is intended to develop learners' ability to identify a course of action and follow this through to produce a viable solution to an agreed specification and timescale. The outcome of the project will form a substantial part of this unit.

The end result of the project could be an engineered product, device, service or process or a modification to an existing process or product. As in the real world, the outcome of the project and its presentation are very important, although this unit is also about the skills of developing and carrying out a project. Throughout the project learners will apply the technical skills developed in other units of the qualification.

This unit presents opportunities for learners to extend their planning, research, critical thinking, analysis, synthesis, evaluation and presentation skills and to demonstrate key skills in application of number, communication, information communication technology and improving own learning and performance.

Learning outcomes

On completion of this unit a learner should:

1 Be able to specify a project, agree procedures and choose a solution

2 Be able to plan and monitor project

3 Be able to implement the project within agreed procedures and to specification

4 Be able to present the project outcome

Unit content

1 **Be able to specify a project, agree procedures and choose a solution**

Project records: written eg notes, sketches, drawings; plans and modified plans; targets (setting, monitoring); use of planning tools eg paper based, electronic

Initial concepts: setting limits eg time, cost, feasibility, need; value–cost–benefit analysis; recording methods eg lists, notes, mind mapping, flow diagrams; research techniques; lines of communication

Specification: type of project eg product design, plant layout/maintenance, production methods or similar engineering-related topics; technical information eg functionality, reliability, operational conditions, process capability, scale of operation, size, capacity, cost, style, ergonomics, present and future trends; health and safety issues; quality standards and legislation; timescales; physical and human resource implications

Procedures: roles and responsibilities eg decision making, budget planning and control; reporting methods; resource allocation and limits

Techniques: brainstorming; comparison methods eg statistical, graphical, quality and resource requirements/limitations, process capability, fitness-for-purpose; analysis eg cost–benefit, feasibility

2 **Be able to plan and monitor a project**

Planning: long-term planning eg planners, charts and scheduling techniques (flow charts, Gantt charts, critical path methods, software packages); setting priorities; useful resource information eg human and physical; monitoring and recording achievement eg record keeping (such as contacts — names, addresses, telephone numbers), results data or performance records, modified charts/planners; day-to-day monitoring eg use of logbooks and/or diary

3 **Be able to implement the project within agreed procedures and to specification**

Implement: proper use of resources eg equipment, tools, materials, within agreed timescale, use of appropriate techniques for generating solutions, adapting project plan where appropriate, maintaining appropriate records

Checking solutions: use of evaluative and analytical techniques eg graphs, statistics, Gantt charts, sequencing, scheduling, critical path methods, use of computer software packages

4 **Be able to present the project outcome**

Present: logbook/diary record of all events; written technical report including relevant drawings/circuit diagrams, sketches, charts, graphs etc appropriate to the project solution; use of information and communication technology (ICT) as appropriate to present findings eg CAD, DTP, spreadsheets, databases, word processing

Presentation: oral presentation to small group eg audience including known (peer group, tutors) and unknown (actual or simulated customer or client) participants; use of preparation techniques, presentation styles and techniques; preparation and use of visual aids eg overhead transparencies, software packages and projectors, charts, models, video/DVD clips

Grading grid

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

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 the learner is able to:**	**To achieve a distinction grade the evidence must show that the learner is able to:**
P1 prepare and maintain project records from initial concepts through to solution that take account of and record changing situations	M1 maintain records throughout the project that are detailed, concurrent and clearly show progress made and the difficulties experienced	D1 independently manage the project development process, seeking support and guidance where necessary
P2 prepare a project specification and the procedures to be followed	M2 use a wide range of techniques and justify the chosen option	D2 critically evaluate the project development process and solution, including proposal for improvement.
P3 use techniques to identify and evaluate three potential solutions to the project specification and select the best option for development	M3 present coherent and well-structured development records and final project report.	
P4 outline the chosen project solution and plan for its implementation		
P5 monitor and record achievement during the life cycle of the project		
P6 implement the plan and produce the project solution		

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 the learner is able to:**	**To achieve a distinction grade the evidence must show that the learner is able to:**
P7 check the solution for conformity with the project specification P8 present a written project report P9 prepare and deliver a presentation to a small group outlining the project specification and proposed solution.		

Essential guidance for tutors

Delivery

Centres will need to consider how the unit content will be delivered eg drawing, sketching, planning skills and techniques etc. Some aspects of the content may be supported by other units in the programme and therefore may have already been covered. However, a large proportion will need to be delivered either before learners start the project work or sequenced to coincide with the need for specific skills and understanding. Ideally, learners should have the knowledge and skills associated with the content for learning outcomes 1, 2 and 3 before they start specifying, planning or implementing the project. Report writing and presentation skills could be left until later but, typically, opportunities to gain, use and practise these skills may well have already been taken in other units.

The 120 guided learning hours for this unit will provide a sufficient amount of time to address the requirement to implement a substantial project outcome and solution.

This unit outlines the learning outcomes as specifying a project and procedures, choosing a solution, planning and monitoring, implementing and presenting the project outcome. The activities associated with assessment relate to managing, using resources, developing, realising and reviewing skills. As such the amount of time spent by the learners and therefore support for the learners during the delivery of the unit is likely to be matched accordingly to those skills required. It would be expected that around a fifth of the time would be relating to managing the selection, planning and the delivery of the project, and a further fifth of the time would be relating to using resources such as obtaining and selecting information and analysing data. Just under half of the time may be best used in developing and realising the solution and project outcome through the use of a range of skills, including new technologies, to solve problems, take decisions and achieve the planned outcomes. The rest of the time, around a fifth can be aligned to reviewing the outcomes and selecting and using a range of communication skills to present the project outcomes.

The unit requires learners to take a considerable amount of responsibility for their own work. It is important to recognise this and ensure that learners are aware of the need to organise and plan their work from the beginning.

Learners should be encouraged to set targets and check their progress regularly, both on an individual and, if applicable, a group/team basis. They should also be asked to create and maintain an individual portfolio of work which will contain evidence used in the assessment of the unit. This logbook/diary can be used to record progress of work, problems encountered, meetings and conversations — in fact, everything to do with the day-to-day progress of the project. This record should be maintained regularly to ensure a log of events as they happen.

Learners should be encouraged to consider the environmental impact of their project solutions and the effect of the European Union eg standards and legislation. They will also need to consider any health and safety implications that impact upon their project work and solution.

Throughout this unit, and particularly during workshop and laboratory time, if applicable, the tutor should ensure that learners are made aware of relevant health and safety issues. No learner should use any equipment or process that they have not been trained to use, nor should they be allowed to use machinery without appropriate levels of supervision.

Choosing an appropriate project

The end result of the project should be an engineered solution that is both relevant to the learner's field of study and that will draw upon what they have learned while studying the other units of their programme. The engineered solution may lead to some form of product or device. The end result could equally lead to a system of work, a process or a procedure or to a modification to an existing process or product. The best projects come from the initial identification of a genuine need or requirement.

Whatever type of project is undertaken, it is important to realise that the actual problem must be deliverable. Centres should allocate enough time to ensure that quality outcomes can be achieved against the project specification and be assessed. The project has to be feasible within the time available and, as project supervisor, the tutor should provide suitable guidance on this. Tutors may also need to help learners when they are in the process of finding a set of 'customer needs' for their project.

Some examples of a project outcome for learners studying the aerospace pathway include:

- modification of an aeronautical product
- specifying and designing an aeronautical system
- testing an aeronautical product.

Examples of possible project outcomes for learners studying the communication technology pathway include:

- specifying, designing and building an integrated hardware/software system
- testing an electronic/electrical service
- modification of a telecommunication product
- specifying and designing a telecommunication system
- testing a telecommunication product.

For learners studying the electrical/electronic pathway examples of project outcomes could include:

- modification of an existing electronic/electrical product
- specifying, designing and building an integrated hardware/software system
- testing and evaluation of an electronic/electrical system or service
- comparison and evaluation of a range of electronic/electrical CAD tools and systems.

Examples of project outcomes for learners studying the mechanical pathway include:

- modification of a mechanical product
- specifying and designing a mechanical system
- testing a mechanical product.

Examples of possible project outcomes for learners studying the manufacturing pathway include:

- modification of a manufactured product or service
- designing and building a manufactured product
- testing a manufactured product or service.

Some examples of project outcomes for learners studying the operations and maintenance pathway include:

- modification of plant services
- designing and building an inspection/calibration test rig
- testing plant service systems or sub-systems.

It is important to remember that learners are looking for a problem or task to be solved, not for a finished item as a starting point.

Strategy and project implementation

Before learners begin work on the project, they need to be able to agree:

- individual responsibilities
- a budget for resources.

Learners may be working alone (a strongly recommended approach) or as members of a team. If working in a team they will need to agree the topic with the other team members. If the project is to be carried out as part of a team, it will be essential to make sure that each team member has clear responsibilities and that everyone makes a contribution to the end result and every process/stage of the project. It is important to be clear about who is responsible and accountable for each aspect of the work. Each member of the team must produce their own evidence against all the criteria in the unit as evidence cannot be shared. Regular progress meetings with the project supervisor (eg tutor and/or employer) are essential and a record must be kept of what is said and agreed. Each member of the team must be accountable for their own project outcome and solution.

To ensure a satisfactory outcome, learners will need to liaise with the customer and/or the project supervisor and, if appropriate, other members of the team throughout all stages of the project. It should be noted, however, that once the initial brief for the project has been clarified the tutor's role becomes one of counselling and supporting rather than directing. As the project outcome and solution are assessed against the project specification it is important that the tutor guides each learner to ensure completion of their project.

After the final presentations it could be useful to have a feedback/debriefing plenary so that learners can benefit from comments on good and bad practice. It is strongly recommended that employers are, wherever possible, involved in the project work, particularly the presentation or plenary sessions.

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.

Assessment

Assessment of this unit will primarily be based on the learner's logbook/diary and other records that will provide evidence of the work carried out by individual learners. Use will also be made of the technical project report and the presentation.

It should be noted that the logbook/diary is intended to be a working document and should contain the learner's notes and records as they are made at the time. It does not need to be a well-presented/neat document but should be an effective tool to capture events and information as and when they happen. The tutor/project supervisor could also annotate the logbook/diary to indicate and record their observations and interactions with the learner eg use of ICT, outcomes of meetings, ability to use technical language during discussions etc.

Learners will need to include, possibly as an annexe to the technical report, their own sketches, drawings/circuit diagrams, notes, lists, charts etc to support their project report findings. Appropriate methods of presentation and management of the total package of evidence should be discussed and used by the learner.

Learners will need guidance on the way to write a formal technical report and this may provide an opportunity for specialist input/support on report writing skills. One approach may be to provide this support as a topic within their key skills teaching time. The unit gives learners a valuable opportunity to produce relevant evidence towards both the unit and their key skills portfolio. Learners may well be working closely with their own company/employer on their project and, as such, they may be required to adopt the company's own 'house style' for the presentation of the report. This would of course be acceptable since it is in line with standard industry practice and since it is the content of the report (eg its technical information, presentation methods and coherence) that is assessed, not its layout style.

Care should be taken to identify learners who may be genuinely terrified of standing in front of a group to make a presentation. The experience of making such a presentation is valuable and is recommended. However, as a minimum learners only have to make an informal presentation to one or two people (which would reflect the typical minimum required in employment at this level) to achieve the unit. The presentation may be another opportunity for combined evidence towards the unit and the communication key skill.

As many of the activities undertaken by learners will be practical and skills based, it is important to think about the method of capturing and presenting such evidence for assessment purposes. Often, witness testimony or records of tutor observation will be necessary. Copies of these will need to be placed in the final portfolio of evidence.

To achieve a pass, learners will need to prepare and maintain project records from initial concepts through to solution that take account of and record changing situations. They will prepare their project specification, identify the procedures to be followed and be able to discuss and agree the project specification in technical terms. Learners will be able to use techniques to identify potential solutions to the project specification and evaluate these potential solutions to select the best option for development. They will then outline the chosen project solution, plan for its implementation and implement the plan to produce a solution. Enough time should be set aside to ensure the project outcome can be reached. It is important that learners are able to demonstrate their ability to check their solutions for conformity with the project specification throughout the progress of the project. Finally, learners will present a written project report with supporting documentation and also prepare and deliver a presentation outlining their project specification and proposed solution to a small group.

At this level learners will need close supervision and guidance. They are likely to need help and encouragement to identify a suitable project and will probably require further help with each further stage of the process. Close supervision will be required to keep them to a planned timetable. It is also likely that learners at this level will find it difficult to keep a logbook/diary without specific encouragement to do so by the tutor/supervisor.

The typical evidence for P1, P3, P5 and P8 is likely to mainly come from the logbook and any other notes. Annotation of planning documentation to show the changing situations would also be helpful. Tutors may also wish to record some of this performance as an observation record or statements from witnesses. Other supporting evidence may well come from documentation of the use of techniques such as comparison methods, which are likely to be limited at pass level, and analysis work.

P2 could be supported by the project specification itself and a written set of procedures. These would obviously need to be discussed before reaching agreement as there may be some centre restrictions. Witness statements and observation records are very likely to support the actual delivery of the project and its plan as required by P6. Other annotation of planning documents could also support the achievement against this criteria. Annotated photographs of the finished project would help provide evidence for this criteria.

The final pass criteria, P9, will be generated after the project has been declared finished; whether it is completed and satisfies the original need is immaterial as long as opportunities have been taken to support achievement against all other criteria. There is an expectation that a project solution and outcome will be achieved to ensure criteria P6 and P7 can be met. P9 will be a combination of hard copies of what was to be presented, such as handouts, slides etc and witness statements and observation records from those present.

To achieve a merit, learners need to be able to work with greater autonomy and will have produced, and kept to, a workable plan. This will be demonstrated by their ability to maintain records throughout the project that are detailed, concurrent and clearly show progress made and the difficulties experienced (M1). To arrive at their project choice they will have used a wide range of techniques and from the use of these be able to justify their chosen option. The range of techniques used for criteria M2 will need to show both statistical and graphical comparison methods for the potential solutions. Another alternative method will also need to have been used, along with a feasibility statement based on their analysis of potential solutions. Learners will also have presented coherent and well-structured development records and final project report for criteria M3.

The forms of suitable evidence for M1 are likely to be similar to those for pass criteria P1 and P5 together with a statement of difficulties experienced. Evidence for M2 is likely to be in the same form as that for P3 but will need more detail and range, as explained earlier. Evidence for the final merit criteria, M3, will be found within the development/project records and the final written report.

To achieve a distinction, learners will have been able to work consistently towards a successful outcome and in doing so they will have independently managed the project development process, seeking support and guidance where necessary. They will have shown the ability to reflect on their work throughout the project. Through this, they will have been able to critically evaluate the project development process and their solution to make relevant proposals for improvement. The evidence for both criteria is likely to come from the logbook and notes with the addition of witness statements and observation records for D1 and a written statement evaluating the project, including the proposal for improvement, for D2.

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

This unit supports aspects of the Level 3 National Occupational Standards in Business Improvement Techniques particularly:

- Unit 1: Complying with Statutory Regulations and Organisational Safety
- Unit 13: Applying Problem Solving Techniques.

It also supports and contributes towards the knowledge and understanding for the Level 3 National Occupational Standards in Engineering Leadership units:

- Unit 4: Schedule Engineering Activities
- Unit 5: Obtain Resources for Engineering Activities
- Unit 7: Rectify Engineering Problems.

It also supports and contributes towards the knowledge and understanding for the Level 3 National Occupational Standards in Project Management, units:

- Unit 4: Prepare a Project Brief
- Unit 10: Develop Operational Objectives for the Project
- Unit 11: Prepare the Specification of Requirements
- Unit 15: Specify Activities for Project Schedules
- Unit 17: Develop a Detailed Schedule for the Project.

Other BTEC National units that cover engineering processes will support this unit by providing learners with an understanding of the range of engineering that they are likely to come across. It also inks with *Unit 2: Communications for Technician*s and *Unit 9: Commercial Aspects of Organisations Employing Engineers*.

Essential resources

Learners should have access to a wide variety of physical resources, depending on the specific project. Many of these are listed within the individual units which can be integrated with this one. Other data sources and reprographic facilities should also be readily accessible.

Learners may require workshop facilities while carrying out the project and will need to have access to a wide range of relevant catalogues and data sheets.

Centres should try to work closely with industrial organisations in order to bring realism and relevance to the project.

Indicative reading for learners

Textbooks

Due to the nature of the unit, refer to the reading lists of other units in the qualification that relate to the specific aspect learners are investigating. However, the following references may be of general use.

Applegarth M and Posner K — *The Project Management Pocketbook* (Management Pocketbooks, 1998) ISBN 1870471636

Lock D — *Project Management* (Gower Publishing, 2003) ISBN 0566085518

Portney S — *Project Management for Dummies* (Hungry Minds, 2001) ISBN 076455283X

Smith N J — *Engineering Project Management* (Blackwell Science, 2002) ISBN 0632057378

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Application of number Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• designing a solution to an engineering problem • keeping records in their logbook.	N3.1 Plan an activity and get relevant information from relevant sources. N3.2 Use this information to carry out multi-stage calculations to do with: a amounts or sizes b scales or proportion c handling statistics d using formulae. N3.3 Interpret the results of your calculations, present your findings and justify your methods.
Communication Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• researching information relevant to their project • keeping a logbook • writing a formal project report • making a verbal presentation • answering questions during their presentation.	C3.1b Make a formal presentation of at least eight minutes using an image or other support material. C3.2 Read and synthesise information from at least **two** documents about the same subject. Each document must be a minimum of 1000 words long. C3.3 Write **two** different types of documents, each one giving different information about complex subjects. One document must be at least 1000 words long.

Information and communication technology Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• researching for their project work • producing a formal project report.	ICT3.1 Search for information, using different sources, and multiple search criteria in at least one case. ICT3.3 Present combined information such as text with image, text with number, image with number.
Improving own learning and performance Level 3	
When learners are:	**They should be able to develop the following key skills evidence:**
• working to a project plan • holding progress meetings with their project supervisor.	LP3.1 Set targets using information from appropriate people and plan how these will be met. LP3.2 Take responsibility for your learning, using your plan to help meet targets and improve your performance. LP3.3 Review progress and establish evidence of your achievements.