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Cambridge TECHNICALS 2016 16

Cambridge TECHNICALS LEVEL 3

FINANUAL

ENGINEERING

Unit/24

Project management for engineers

T/615/1558 Guided learning hours: 90 Version 1

+ 10."

ocr.org.uk/engineering

LEVEL 3

UNIT 24: PROJECT MANAGEMENT FOR ENGINEERS

T/615/1558

Guided learning hours: 90

Essential resources required for this unit: none

This unit is externally assessed by an OCR set and marked examination.

Unit aim

Engineering organisations undertake projects of all kinds that vary in terms of purpose and scope. Some examples of engineering projects include designing a new or replacement product, utilising new technology to improve an existing product or service, utilising new materials, lowering wastage, improving the production process, setting up bespoke production or improving the quality or quantity of output from mass production. A project comprises a range of tasks and activities to be carried out in a particular sequence in order to reach an intended purpose. Being able to prepare and manage a project is an important skill needed by many different people working in engineering and manufacturing organisations.

In this unit you will learn about the stages of project management and the type of skills a project manager should have. You will learn about the importance of project planning and how to use a range of project planning tools. You will be made aware of internal and external factors which might have an impact on the planning, implementation and closure of a project. You will learn why you need to monitor the progress of a project through to implementation and closure. In addition, you will learn the importance of measuring the success of a project and how lessons learned can feed into future projects.

The failure of engineering projects to deliver on time and on cost has jeopardised the future of many businesses, large and small. Engineers who combine their subject expertise with project management are better positioned to contribute to the overall success of the organisation. For this reason, engineers with knowledge and expertise in effective project management have a skill which employers value highly.

TEACHING CONTENT

The unit content describes what has to be taught to ensure that learners are able to access the highest grade.

Anything which follows an i.e. details what must be taught as part of that area of content.

Anything which follows an e.g. is illustrative.

Where teaching content contains i.e. and e.g. under specific areas of content, the following rules will be adhered to when we set questions for an exam:

- A direct question may be asked about unit content which follows an i.e.
- Where unit content is shown as an e.g. a direct question will not be asked about that example.

Learning Outcome The Learner will:		Teaching Content The Learner must be taught:		Teaching exemplification
 Understand the stages of project management 	1.1	 The stages of project management, i.e.: 1. project initiation, i.e.: a. project proposal (including purpose of project, aims, scope and deliverables) b. feasibility study (including costings and justification for proposed project) c. project controls (including time, cost and quality strategies) d. communication strategy (including reporting and information sharing) 	1.1	To include purposes, key tasks, importance of and reasons for each of the four stages of project management. Learners need to understand that the four stages of project management - initiation, planning, implementation and closure – are consecutive and need to be carried out sequentially.

Learning Outcome e Learner will:		Teaching Content The Learner must be taught:		Teaching exemplification
	1.2	 Project planning i.e.: outline plan (including purpose, aims, objectives, scope, constraints, deliverables, targets, communication and controls) resource plan (including physical, technological and human resources) financial plan (including budget spend, costing, pricing and sources of finance) quality plan (including quality targets and quality control methods) stakeholder analysis (including internal and external stakeholders, power versus interest and stakeholder management) risk analysis (including identification of risks, severity of risks, likelihood of risk and risk owners) contingency plan (including allowing time and budget for risks related to physical, technological and human resource issues) project schedule (including activities involved, order of completion and timings 	1.2	The outline plan requires objectives. Objectives should be specific, measurable, agreed, realistic and time specific (SMART). The resource plan to include what, where and when resources are required for example what tools are required and where they will be stored, the dates equipment is needed and where it should be delivered and when specialist people need to be hired. The financial plan to include: time scales and budget spend, calculation of unit and total costs, and key features of sources of finance (including internal/external sources, short/medium/long term, debt /equity finance and the advantages and disadvantages of different sources). The stakeholder analysis to include how to manage different stakeholders for example low interest, low power – monitor; high interest, low power – monitor; high interest, high power – keep informed; low interest, high power – manage closely. The risk analysis to include specific, contextualised examples of risks for a particular project. Learners need to understand the distinction between a risk and a hazard. Lessons learned to include strengths, weaknesses and areas for improvement. Lessons learned should be used to improve the organisation's future performance and knowledge base.

Learning Outcome The Learner will:		Teaching Content The Learner must be taught:		Teaching exemplification
	1.3	 project implementation i.e.: 1. execution (including issue logs and reporting) 2. monitoring (including comparison with project schedule and variance analysis) 3. control (including approving changes, taking corrective action, making proactive and reactive adjustment) 		
	1.4	 project closure, i.e.: 1. obtain final acceptance of project completion 2. produce the final project report 3. obtain feedback from relevant stakeholders 4. review lessons learned 	1.4	As part of project closure, final acceptance needs to be obtained from relevant stakeholders to confirm that the project deliverables have been achieved. The final project report should be distributed to relevant stakeholders to convey project performance and assist in project evaluation. Feedback from relevant stakeholders should be used to evaluate stakeholder satisfaction with the way the project was managed and its outcomes.
2. Understand project management roles and the skills needed to be an effective project manager	2.1	 Project management roles i.e.: 1. project sponsor 2. project board/steering committee 3. project team i.e.: a. project manager b. project team leaders c. project team members 4. end user/customer 5. other stakeholders (including consultants and contractors) 	2.1	To include the reasons for each role and the key duties and responsibilities of each role.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		The Learner must be taught:		
	2.2	 Skills needed to be an effective project manager, i.e.: 1. planning (including scheduling what needs to be done by who and adjusting the plan when necessary) 2. time management (including duration of tasks, realistic timescales, measuring progress, keeping project on track and meeting agreed deadlines) 3. decision-making (including critical thinking and problem solving) 4. communication (including internal/external communication, use of appropriate channels of communication, timing, quality, fitness for purpose) 5. negotiation (including to project sponsors, key stakeholders, resource holders, project leaders and project team members) 6. delegation (to resource holders, project leaders and project team members) 7. leadership (including directive, supportive, collaborative and responsive leadership styles) 8. team building (including establishing rapport, active listening and motivating the project team) 9. conflict management (including conflict avoidance, conflict mitigation, managing competing priorities for resources, managing tension within project team members and between stakeholders) 10. information management (including cost control, risk mitigation and assessment of performance) 	2.2	To include the benefits and limitations, reasons for and importance of each skill. To include recommendations for appropriate use of skills and courses of action to improve the effectiveness of the management of a project. To include the consequences to a project of a project manager lacking suitable skills and recommendations for improvement.
 Be able to use project management tools 	3.1	 How to use and interpret a Gantt chart i.e.: 1. sequence of activities 2. duration of activities 3. concurrent activities 4. dependent activities 5. minimum completion time 6. slack time 7. critical activities 8. delays and adjustments 	3.1	To include the usefulness (advantages and disadvantages) and importance of Gantt charts for project management and the interpretation of Gantt chart data.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		The Learner must be taught:		
	3.2	 How to use a critical path analysis i.e.: 1. critical path network diagrams 2. earliest start times (EST) 3. latest finish times (LFT) 4. float time for an activity 5. the identification of a project's critical path 6. minimum completion time 7. delays and adjustments 	3.2	To include the usefulness (advantages and disadvantages) and importance of critical path analysis for project management and the calculation and interpretation of critical path data.
	3.3	 How to calculate and use the Program Evaluation and Review Technique (PERT) i.e.: 1. optimistic time (O) 2. pessimistic time (P) 3. most likely time (M) 4. estimated expected time (E) 	3.3	To include the usefulness (advantages and disadvantages) and importance of PERT for project management and the interpretation of PERT data. Learners should use and recall the formula used in PERT to calculate the estimated expected duration of a project E = O + 4M + P
 Be able to use information to support project 	4.1	The use of different types of information i.e.:1. qualitative and quantitative2. actual and forecasted	4.1	To include the meaning, strengths, weaknesses and examples of each type of information.
management decisions	4.2	 The use of different sources of information i.e.: 1. internal (e.g. corporate aims, technical data, performance data, costings, pricing, Gantt charts, critical path data, PERT) 2. external (e.g. customers, competitors, industrial averages, industrial standards, market conditions, economic data, government data) 	4.2	To include the meaning, strengths, weaknesses and examples of different sources of information.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will:		The Learner must be taught:		
	4.3	 The use of different types of research i.e.: 1. primary research methods (including interviews, questionnaires, observation, surveys, focus groups, product testing, performance statistics, variance analysis) 2. secondary research sources (including internal data, government data, trade data, the Internet) 	4.3	To include the benefits and limitations of both types of research. This should be linked to a consideration of the reliability and usefulness of the research in the context of specific engineering projects.
	4.4	How to judge the validity of information used when managing an engineering project i.e.: 1. Consideration of: a. integrity of source b. bias of source c. relevance d. complexity e. degree of detail f. currency (up to date) g. quality h. accuracy i. reliability j. importance	4.4	Learners need to be able to judge the validity of information in the context of specific engineering projects. To include numerical and non-numerical information.
	4.5	 How to collate and use information to manage an engineering project i.e.: 1. organise i.e. group, rank, prioritise 2. present i.e. in writing, tabular, graphically 3. interpretation of key findings 4. make decisions using information available 	4.5	Learners need to be able to use given information to make decisions or recommendations in the context of specific engineering projects. To include numerical and non-numerical information.

Learning Outcome		Teaching Content		Teaching exemplification
The Learner will: The Learner must be taught:		The Learner must be taught:		
5. Understand how and why projects are monitored	5.1	 How projects are monitored i.e.: 1. use of project management tools 2. comparison of actual with planned (including time creep, quality erosion, budget overrun) 3. quality management 4. control techniques 5. frequent reporting 	5.1	Learners should consider practical examples from real engineering projects and be able to recommend ways which a specific engineering project could be monitored.
	5.2	 Why projects are monitored i.e.: 1. project outcomes are affected by internal factors i.e.: a. organisational aims and objectives b. organisational procedures and policies (including ethics and corporate social responsibility) c. scale and scope of the project d. resource constraints (including access, quality, quantity, cost, continuity of supply, expertise, timing) i.e.: i. physical (including premises, tools, equipment, facilities, materials, consumables) ii. technological (including computer hardware, software, networks, advancing technologies) iii. human (including support of senior management, skills of project manager, training of team members) e. poor leadership (including not updating schedules, lack of coordination of activities, no contingencies) f. poor planning (including market size, market power, market dynamics) c. competition (including nature, size, strength of competition and competitor behaviour) d. other external factors (i.e.: political, economic, social, technological, legal, environmental (PESTLE)) 	5.2	Learners should consider practical examples from real engineering projects. Learners need to understand that however good the planning stage, internal or external factors can impact on the delivery of an engineering project and affect its success. Project delivery needs to be constantly monitored so that remedial action can be taken as soon as possible to minimise cost and keep the project on track.

Learning Outcome Teaching Content Teaching exemplification		Teaching exemplification		
The Learner will:	The Learner will: The Learner must be taught:			
 Understand how to measure the success of a project 	6.1	Types of feedback on success of project i.e.:1. objective (i.e.: based on measurable facts)2. subjective (i.e.: based on opinion, attitudes, beliefs, reputation)	6.1	The success of a project is measured by judging how well the aims and objectives of the project have been met. Feedback from different stakeholders is used to help judge the success of the project.
	6.2	 Methods that can be used to gather feedback i.e.: 1. objective feedback methods i.e.: a. completion figures (e.g. deliverables, scope, time, cost, acceptance) b. issue logs c. complaints analysis 2. subjective feedback methods i.e.: a. informal methods (e.g. chat, media coverage) b. formal methods (e.g. meetings, questionnaires) 	6.2	To include the key features, benefits and limitations of different methods.
	6.3	 Uses of feedback collected at the end of an engineering project to i.e.: 1. recognise project successes and failures 2. monitor and measure stakeholder satisfaction 3. identify project strengths and weaknesses 4. identify lessons learned 5. inform future projects 6. drive business improvement (including 7. training, expertise, documentation, procedures) 8. review personal performance 	6.3	To include benefits of feedback to those with project management roles (including project sponsors, project board/steering committee, project manager, project leaders, project team members, end user/customer and other stakeholders such as consultants and contractors) and recommendations for improvement.

SYNOPTIC ASSESSMENT AND LINKS BETWEEN UNITS

It will be possible for learners to make connections between other units over and above the unit containing the key tasks for synoptic assessment, please see section 6 of the centre handbook for more detail.

Links between this unit and other units

This unit and specific LO	Name of other unit and related LO
LO1 Understand the stages of project management	Unit 18 LO1 1.1 1.2 1.3
	Unit 20 LO 2 2.1 2.2 2.3
LO2 Understand project management roles and the skills	Unit 18 Lo 4 4.1 4.2 4.3 4.4
needed to be an effective project manager	Unit 20 LO1 1.1 1.2 1.3
LO3 Be able to use project management tools	Unit 1 LO1 1.1 1.2 LO 6 6.1 6.2 6.3
	Unit 18 LO 2 2.1 2.2 2.3 2.4
	Unit 20 LO 2 2.1 2.2 2.3
	Unit 21 LO 3 3.1 3.2
LO4 Be able to use information to support project	Unit 1 LO 6 6.1 6.2 6.3
management decisions	Unit 18 LO 2 2.1 2.2 2.3 2.4
	Unit 20 LO2 2.1 2.2 LO3 3.1 3.2 3.3 3.4
LO6 Understand how to measure the success of a project	Unit 1 LO 6 6.1 6.2 6.3
	Unit 18 LO 4 4.5 4.6 4.7 4.8
	Unit 20 LO 2 2.1 2.2 LO4 4.1 4.2 LO5 5.1 5.2 5.3 5.4
	Unit 21 LO 3 3.1 3.2

ASSESSMENT GUIDANCE

All LOs are assessed through an externally set written examination paper, worth a maximum of 80 marks and 2 hours in duration. Learners should study the principles and practice of engineering project management and delivery, as outlined in the teaching content. It will be of benefit to learners to examine real-life case studies which will show the scale and scope of engineering projects in different size organisations, and how such projects are managed and delivered.

Exam papers for this unit will be based on an engineering project scenario. The paper will include contextual questions based on this scenario as well as questions to demonstrate a more general understanding of the project management. Questions will provide opportunity for learners to demonstrate their ability to apply and interpret their learning to the context of the scenario given in the exam paper. During the external assessment, learners will be expected demonstrate their skills of analysis and evaluation in the context of the given engineering scenario.

LEARNING OUTCOME WEIGHTINGS

Each learning outcome in this unit has been given a percentage weighting. This reflects the size and demand of the content you need to cover and its contribution to the overall understanding of this unit. See table below:

LO1	10-30%
LO2	10-30%
LO3	7-23%
LO4	10-30%
LO5	10-30%
LO6	7-23%

TEACHING GUIDANCE

1.1 Use real engineering projects, case studies and examples from learners' own experience to identify and to clarify the four stages of project management. Learners could be given real examples of project documentation to study, so that they can see first-hand how a project is broken down into different stages, so that a successful outcome can be obtained.

2.1 Learners need to be familiar with the roles and responsibilities of different project management roles. It would be helpful if learners could be introduced to a live engineering project and meet the various stakeholders. Failing this a photograph board with links to the key duties of specific personnel for a particular project could be used.

2.2 Learners may well be familiar with most, if not all, of the itemised skills. Tutors should help learners appreciate the benefits to a project manager of having each of these skills, and how these skills can be used to best effect in various situations. This can be brought alive through role play, with learners taking it turn to use, and to be on the receiving end, of the different styles of leadership or ways of handling a particular situation. Learners' own experience could be shared as the starting point for team building. Tutors need to pick up and expand on positive examples and encourage learners to make suggestions of what would make team building stronger. A team project in the context of an engineering project could be instigated to illustrate how teams can be built and strengthened. A team building failure can be used to emphasise the importance of group cohesion. Learners need to understand the importance of negotiation, and how in practice this can be achieve. Once again role play will provide a safe environment for exploring these skills.

3.1 Learners need to be introduced to the concept of activity sequencing, dependent activities and critical activities (i.e. activities which if delayed, delay the entire project). Learners should be shown how to interpret and use a Gantt chart. To aid understanding it may help if learners produce a Gantt chart

retrospectively for a project in which they have been involved. Learners need to be given plenty of real or simulated data to practice understanding the data on Gantt charts and be able to make alterations to the chart as necessary.

3.2 Learners need to be introduced to critical path network diagrams and their uses. It will help learners if they have plenty of practice at calculating EST, LFT and float time. It is important to stress that when completing a critical path network diagram that learners should work from left to right to complete the ESTs and from right to left to complete the LFTs. Learners should then be encouraged to quiz the diagram to see where float time exists and the effects on overall completion time if activities are delayed or completed early. Learners could also consider the reallocation of resources or the restructuring of activity sequence to improved project delivery.

3.3 Learners should be introduced to the concept of optimistic time, pessimistic time and most likely time to complete a project. They should be familiar with the formula used in PERT to calculate the estimated expected duration of a project i.e. (O + 4M + P)/6. They need to consider the usefulness of using PERT when planning and monitoring a project.

4.1 – 4.3 Where possible tutors should use a range of real-life examples to identify different types of information, sources and types of research. Learners should be encouraged to study the relative strengths and weaknesses of each. This could be done as a group activity, brain storming to produce a spider diagram to share with the class.

4.4 Judging the validity of information is best done through practical experience. Learners should be encouraged to conduct their own research, based on the needs of a specific project. They could produce a scrap book of information which was rejected, annotated with the reasons for their rejection.

4.5 Learners need to develop skills to collate and use information to manage an engineering project. A good starting point would be to use the information which they sourced in 4.4. In the examination, learners will be presented with unfamiliar information, it is therefore important that they are given plenty of practice at manipulating unseen data, presenting it in various form and using it to make decisions.

5.1 Where possible learners should study how projects are monitored at first-hand. Where this is not possible videos (often available on public Internet sites) could be used in combination with a class discussion on the benefits and drawbacks of different methods.

5.2 Again, where possible real engineering projects should be used, these could be ones with which learners have been involved or projects undertaken by organisations large and small. Learners need to understand that however good the plan, reality always plays its part. Learners could produce a two-minute podcast to broadcast to their class covering the internal and/or internal factors which have affected an engineering project they have studied.

6.1 Learners need a clear understanding of the difference between objective feedback and subjective feedback and the value of each. There are several quizzes on the Internet which could be used to distinguish between the two types of feedback. Learners could be encouraged to create a quiz of their own to distinguish between feedback types and a PowerPoint presentation to explain the value of each type of feedback.

6.2 Tutors could use a practical exercise to give learners the experience of collecting feedback data, either for their own project, or on behalf of an external organisation. Tutors should be aware that some feedback information may be sensitive or confidential and guide learners how to handle this accordingly.

6.3 Tutors will need to make sure that learners understand the concept of being a stakeholder in a project, using learners' own position with a range of projects and life experience to illustrate. Learners could produce mind maps of the benefits of project feedback for a range of different stakeholders.

MEANINGFUL EMPLOYER INVOLVEMENT - a requirement for the Foundation Diploma, Diploma and Extended Diploma (tech level) qualifications

The 'Diploma' qualifications have been designed to be recognised as Technical Levels in performance tables in England. It is a requirement of these qualifications for centres to secure employer involvement through delivery and/or assessment of these qualifications for every learner.

The minimum amount of employer involvement must relate to at least one or more of the elements of the mandatory content.

Eligible activities and suggestions/ideas that may help you in securing meaningful employer involvement for this unit are given in the table below.

Please refer to the Qualification Handbook for further information including a list of activities that are not considered to meet this requirement.

Me ac	eaningful employer involvement – eligible tivities	Suggestion/ideas for centres when delivering this unit
1.	Students undertake structured work- experience or work-placements that develop	Work placements in engineering businesses; this could be an SME with the opportunity for learners to observe/ experience project management.
	skills and knowledge relevant to the qualification.	Learners are introduced to the project management of engineering operations to appreciate the importance of each stage.
2.	Students undertake project(s), exercises(s) and/or assessments/examination(s) set with input from industry practitioner(s).	Centres can develop assignments in association with engineering organisations so that learners work on real-life projects set by industry that are mapped to the criteria of the unit.
		Engineering organisations set learners challenges where learners have to carry out project planning of an engineering operation or a process/product/component, which involves multiple business stakeholders, using project planning tools.

You can find further information on employer involvement in the delivery of qualifications in the following documents:

- Employer involvement in the delivery and assessment of vocational qualifications
- DfE work experience guidance

To find out more ocr.org.uk/engineering or call our Customer Contact Centre on 02476 851509

Alternatively, you can email us on vocational.qualifications@ocr.org.uk







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