Pearson BTEC Level 3 Diploma in Automotive Clay Modelling (QCF)

Specification

Pearson BTEC Specialist qualification

First teaching July 2014

Issue 2

Edexcel, BTEC and LCCI qualifications

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All information in this specification is correct at time of publication.

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Summary of Pearson BTEC Level 3 Diploma in Automotive Clay Modelling (QCF)

Issue 2 changes

Summary of changes to the previous issue	Page number
Updated qualification structure	7 & 8
Addition of two units: T/502/4976 – Design Methods in Art and Design (Unit 18) K/502/5266 – Human-scale Working (Unit 19)	175–190

Contents

Purpose of this specification

The purpose of a specification as defined by Ofqual is to set out:

- the qualification's objective
- any other qualification that a learner must have completed before taking the qualification
- any prior knowledge, skills or understanding that the learner is required to have before taking the qualification
- units that a learner must have completed before the qualification will be awarded and any optional routes
- any other requirements that a learner must have satisfied before they will be assessed or before the qualification will be awarded
- the knowledge, skills and understanding that will be assessed as part of the qualification (giving a clear indication of their coverage and depth)
- the method of any assessment and any associated requirements relating to it
- the criteria against which the learner's level of attainment will be measured (such as assessment criteria)
- any specimen materials
- any specified levels of attainment.

1 Introducing Pearson BTEC Specialist qualifications

For more than 25 years, Pearson BTECs have earned their reputation as well-established, enduringly effective qualifications. They have a proven track record of improving motivation and achievement. Pearson BTECs also provide progression routes to the next stage of education or to employment.

What are Pearson BTEC Specialist qualifications?

Pearson BTEC Specialist qualifications are qualifications from Entry to Level 3 on the Qualifications and Credit Framework (QCF). They are work-related qualifications and are available in a range of sectors. They give learners the knowledge, understanding and skills they need to prepare for employment. They also provide career development opportunities for those already in work. These qualifications may be full-time or part-time courses in schools or colleges. Training centres and employers may also offer these qualifications.

Some Pearson BTEC Specialist qualifications are knowledge components in Apprenticeship Frameworks, i.e. Technical Certificates.

There are three sizes of Pearson BTEC Specialist qualification in the QCF:

- Award (1 to 12 credits)
- Certificate (13 to 36 credits)
- Diploma (37 credits and above).

Every unit and qualification in the QCF has a credit value.

The credit value of a unit specifies the number of credits that will be awarded to a learner who has achieved the learning outcomes of the unit.

The credit value of a unit is based on:

- one credit for every 10 hours of learning time
- learning time – defined as the time taken by learners at the level of the unit, on average, to complete the learning outcomes to the standard determined by the assessment criteria.

2 Qualification summary and key information

Qualification title	Pearson BTEC Level 3 Diploma in Automotive Clay Modelling (QCF)
QCF Qualification Number (QN)	601/3481/1
Qualification framework	Qualifications and Credit Framework (QCF)
Accreditation start date	01/07/2014
Approved age ranges	16–18 19+
Credit value	120
Assessment	Centre-devised assessment (internal assessment)
Guided learning hours	720
Grading information	The qualification and units are at pass grade.
Entry requirements	No prior knowledge, understanding, skills or qualifications are required before learners register for this qualification. However, centres must follow the Pearson Access and Recruitment policy (see *Section 10 Access and recruitment*).

QCF qualification number and qualification title

Centres will need to use the QCF Qualification Number (QN) when they seek public funding for their learners. As well as a QN, each unit within a qualification has a QCF unit reference number (URN).

The qualification title, unit titles and QN will appear on each learner's final certificate. You should tell your learners this when your centre recruits them and registers them with us. There is more information about certification in our *UK Information Manual,* available on our website.

The Pearson BTEC Level 3 Diploma in Automotive Clay Modelling (QCF) is for learners who work in, or want to work in the Automotive Industry. It gives learners the opportunity to:

- demonstrate competence as an Automotive Clay Modeller within the Automotive Industry
- develop knowledge and skills related to the specified job roles in the Automotive Industry
- have existing skills recognised
- achieve a nationally-recognised Level 3 qualification
- develop their own personal growth and engagement in learning.

Apprenticeships

Semta approves the Pearson BTEC Level 3 Diploma in Automotive Clay Modelling (QCF) as a knowledge component for the Advanced Apprenticeship in Automotive Clay Modelling. The Pearson Edexcel Level 3 NVQ Diploma in Automotive Clay Modelling (QCF) as the competence component for the Advanced Apprenticeship in Automotive Clay Modelling.

Relationship with previous qualifications

This is a new qualification.

Progression opportunities through Pearson qualifications

Learners who have achieved the Pearson BTEC Level 3 Diploma in Automotive Clay Modelling (QCF) can progress to the Pearson Edexcel Level 3 NVQ Diploma in Automotive Clay Modelling (QCF).

Industry support and recognition

This qualification is supported by Semta, the Sector Skills Council for Engineering.

Relationship with National Occupational Standards

This qualification is based on the National Occupational Standards (NOS) in Engineering, which were set and designed by Semta, the Sector Skills Council for the sector.

3 Qualification structure

Pearson BTEC Level 3 Diploma in Automotive Clay Modelling (QCF)

The learner will need to meet the requirements outlined in the table below before Pearson can award the qualification.

Minimum number of credits that must be achieved	120
Number of mandatory credits	60
Number of optional credits (30 credits from Group A and 30 from Group B)	60

Unit	Unit reference number	Mandatory units Learners must achieve all 60 credits from this group	Level	Credit	Guided learning hours
1	T/600/0249	Health and Safety in the Engineering Workplace	3	10	60
2	A/502/5515	Product Design	3	10	60
3	A/600/0253	Mathematics for Engineering Technicians	3	10	60
4	K/502/5736	Ideas and Concepts in Art and Design	3	10	60
5	T/600/0252	Engineering Project	3	20	120
Unit	**Unit reference number**	**Optional units (Engineering Group A)** **Learners must achieve a minimum of 30 credits from this group**	**Level**	**Credit**	**Guided learning hours**
6	R/600/0260	Properties and Applications of Engineering Materials	3	10	60
7*	M/600/0251	Communications for Engineering Technicians	3	10	60
8	F/600/0254	Mechanical Principles and Applications	3	10	60
9	J/600/0255	Electrical and Electronic Principles	3	10	60
10	H/600/0280	Further Mathematics for Engineering Technicians	3	10	60
11*	D/502/4969	Communication Through Art and Design	3	10	60
12	J/502/4965	Visual Recording in Art and Design	3	10	60
18	T/502/4976	Design Methods in Art and Design	3	10	60

Units 7 and 11 are a forbidden combination.

Unit	Unit reference number	Optional units (Design Group B) Learners must achieve a minimum of 30 credits from this group	Level	Credit	Guided learning hours
13	Y/600/0258	Engineering Design	3	10	60
14	T/600/0266	Engineering Drawing for Technicians	3	10	60
15	A/600/0267	Computer Aided Drafting in Engineering	3	10	60
16	A/502/5241	3D Computer Modelling	3	10	60
17	T/502/5268	Human Scale Design	3	10	60
19	K/502/5266	Human-scale Working	3	10	60

4 Assessment

The table below gives a summary of the assessment methods used in the qualification.

Units	Assessment method
All units	Centre-devised assessment

Centre-devised assessment (internal assessment)

Each unit has specified learning outcomes and assessment criteria. To pass an internally-assessed unit, learners must meet all the learning outcomes. Centres may find it helpful if learners index and reference their evidence to the relevant learning outcomes and assessment criteria.

Centres need to write assignment briefs for learners to show what evidence is required. Assignment briefs should indicate clearly which assessment criteria are being targeted.

Assignment briefs and evidence produced by learners must meet any additional requirements in the *Information for tutors* section of the unit.

Unless otherwise indicated in *Information for tutors*, the centre can decide the form of assessment evidence (for example, performance observation, presentations, projects, tests, extended writing) as long as the methods chosen allow learners to produce valid, sufficient and reliable evidence of meeting the assessment criteria.

Centres are encouraged to give learners realistic scenarios and maximise the use of practical activities in delivery and assessment.

To avoid over-assessment centres are encouraged to link delivery and assessment across units.

There is more guidance about internal assessment on our website. See *Section 13 Further information and useful publications*.

5 Recognising prior learning and achievement

Recognition of Prior Learning

Recognition of Prior Learning (RPL) is a method of assessment (leading to the award of credit) that considers whether a learner can demonstrate that they can meet the assessment requirements for a unit through knowledge, understanding or skills they already possess and so do not need to develop through a course of learning.

Pearson encourages centres to recognise learners' previous achievements and experiences in and outside the workplace, as well as in the classroom. RPL provides a route for the recognition of the achievements resulting from continuous learning.

RPL enables recognition of achievement from a range of activities using any valid assessment methodology. If the assessment requirements of a given unit or qualification have been met, the use of RPL is acceptable for accrediting a unit, units or a whole qualification. Evidence of learning must be sufficient, reliable and valid.

Further guidance is available in the policy document *Recognition of Prior Learning Policy*, which is on our website.

Credit transfer

Credit transfer describes the process of using a credit or credits awarded in the context of a different qualification or awarded by a different awarding organisation towards the achievement requirements of another qualification. All awarding organisations recognise the credits awarded by all other awarding organisations that operate within the QCF.

If learners achieve credits with other awarding organisations, they do not need to retake any assessment for the same units. The centre must keep evidence of credit achievement.

6 Centre resource requirements

As part of the approval process, centres must make sure that the resources requirements below are in place before offering the qualification.

General resource requirements

- Centres must have appropriate physical resources (for example, equipment, IT, learning materials, teaching rooms) to support the delivery and assessment of the qualification.
- Staff involved in the assessment process must have relevant expertise and occupational experience.
- There must be systems in place to ensure continuing professional development for staff delivering the qualification.
- Centres must have appropriate health and safety policies in place relating to the use of equipment by learners.
- Centres must deliver the qualifications in accordance with current equality legislation. For further details on Pearson's commitment to the Equality Act 2010, please see *Section 10 Access and recruitment* and *Section 11 Access to qualifications for learners with disabilities or specific needs*. For full details on the Equality Act 2010, please go to the Home Office website, www.gov.uk/government/organisations/home-office

Specific resource requirements

Many units have specific resource requirements that centres must meet. See the details in the Essential Resources section of the unit.

7 Centre recognition and approval centre recognition

Centres that have not previously offered Pearson qualifications need to apply for, and be granted, centre recognition as part of the process for approval to offer individual qualifications.

Existing centres will be given 'automatic approval' for a new qualification if they are already approved for a qualification that is being replaced by a new qualification and the conditions for automatic approval are met.

Guidance on seeking approval to deliver Pearson BTEC qualifications is available our website.

Approvals agreement

All centres are required to enter into an approval agreement that is a formal commitment by the head or principal of a centre to meet all the requirements of the specification and any associated codes, conditions or regulations. Pearson will act to protect the integrity of the awarding of qualifications. If centres do not comply with the agreement, this could result in the suspension of certification or withdrawal of approval.

8 Quality assurance of centres

Quality assurance is at the heart of vocational qualifications. The centre assesses Pearson BTEC qualifications. The centre will use quality assurance to make sure that their managers, internal verifiers and assessors are standardised and supported. Pearson use quality assurance to check that all centres are working to national standards. It gives us the opportunity to identify and provide support, if needed, to certification. It also allows us to recognise and support good practice.

For the qualifications in this specification, the Pearson quality assurance model will follow one of the processes listed below.

1 Delivery of the qualification as part of a BTEC apprenticeship ('single click' registration):

- an annual visit by a Standards Verifier to review centre-wide quality assurance systems and sampling of internal verification and assessor decisions.

2 Delivery of the qualification outside the apprenticeship:

- an annual visit to the centre by a Centre Quality Reviewer to review centre-wide quality assurance systems
- Lead Internal Verifier accreditation. This involves online training and standardisation of Lead Internal Verifiers using our OSCA platform, accessed via Edexcel Online. Please note that not all qualifications will include Lead Internal Verifier accreditation. Where this is the case, we will annually allocate a Standards Verifier to conduct postal sampling of internal verification and assessor decisions for the Principal Subject Area.

For further details, go to the *UK BTEC Quality Assurance Handbook* on our website.

9 Programme delivery

Centres are free to offer the qualifications using any mode of delivery (for example full time, part time, evening only, distance learning) that meets their learners' needs. Whichever mode of delivery is used, centres must make sure that learners have access to the resources identified in the specification and to the subject specialists delivering the units.

Those planning the programme should aim to enhance the vocational nature of the qualification by:

- liaising with employers to make sure a course is relevant to learners' specific needs
- accessing and using non-confidential data and documents from learners' workplaces
- developing up-to-date and relevant teaching materials that make use of scenarios that are relevant to the sector
- giving learners the opportunity to apply their learning in practical activities
- including sponsoring employers in the delivery of the programme and, where appropriate, in the assessment
- making full use of the variety of experience of work and life that learners bring to the programme.

Centres must make sure that any legislation taught is up to date.

10 Access and recruitment

Pearson's policy regarding access to our qualifications is that:

- they should be available to everyone who is capable of reaching the required standards
- they should be free from any barriers that restrict access and progression
- there should be equal opportunities for all those wishing to access the qualifications.

Centres are required to recruit learners to Pearson BTEC Specialist qualifications with integrity.

Applicants will need relevant information and advice about the qualification to make sure it meets their needs.

Centres should review the applicant's prior qualifications and/or experience, considering whether this profile shows that they have the potential to achieve the qualification.

For learners with disabilities and specific needs, this review will need to take account of the support available to the learner during teaching and assessment of the qualification. The review must take account of the information and guidance in *Section 11 Access to qualifications for learners with disabilities or specific needs*.

Learners may be aged between 14 and 16 and therefore potentially vulnerable. Where learners are required to spend time and be assessed in work settings, it is the centre's responsibility to ensure that the work environment they go into is safe.

11 Access to qualifications for learners with disabilities or specific needs

Equality and fairness are central to our work. Pearson's Equality Policy requires all learners to have equal opportunity to access our qualifications and assessments. It also requires our qualifications to be awarded in a way that is fair to every learner.

We are committed to making sure that:

- learners with a protected characteristic (as defined by the Equality Act 2010) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to learners who do not share that characteristic
- all learners achieve the recognition they deserve from undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Learners taking a qualification may be assessed in British sign language or Irish sign language where it is permitted for the purpose of reasonable adjustments.

Details on how to make adjustments for learners with protected characteristics are given in the policy documents *Application of Reasonable Adjustment for BTEC and Edexcel NVQ Qualifications* and *Application for Special Consideration: BTEC and Edexcel NVQ Qualifications*.

The documents are on our website at www.edexcel.com/policies

12 Units

Units have the following sections.

Unit title

The unit title is on the QCF and this form of words will appear on the learner's Notification of Performance (NOP).

Unit reference number

Each unit is assigned a unit reference number that appears with the unit title on the Register of Regulated Qualifications.

QCF level

All units and qualifications within the QCF have a level assigned to them. There are nine levels of achievement, from Entry to Level 8. The QCF Level Descriptors inform the allocation of the level.

Credit value

When a learner achieves a unit, they gain the specified number of credits.

Guided learning hours

Guided learning hours are the times when a tutor, trainer or facilitator is present to give specific guidance towards the learning aim for a programme. This definition covers lectures, tutorials and supervised study in, for example, open learning centres and learning workshops. It also includes assessment by staff where learners are present. It does not include time spent by staff marking assignments or homework where the learner is not present.

Unit aim

This gives a summary of what the unit aims to do.

Unit introduction

The unit introduction gives the reader an appreciation of the unit in the vocational setting of the qualification, as well as highlighting the focus of the unit. It gives the reader a snapshot of the unit and the key knowledge, skills and understanding gained while studying the unit. The unit introduction also highlights any links to the appropriate vocational sector by describing how the unit relates to that sector.

Essential resources

This section lists any specialist resources needed to deliver the unit. The centre will be asked to make sure that these resources are in place when it seeks approval from Pearson to offer the qualification.

Learning outcomes

The learning outcomes of a unit set out what a learner knows, understands or is able to do as the result of a process of learning.

Assessment criteria

Assessment criteria specify the standard required by the learner to achieve each learning outcome.

Unit amplification

This section clarifies what a learner needs to know to achieve a learning outcome.

Information for tutors

This section gives tutors information on delivery and assessment. It contains the following subsections.

- *Delivery* – explains the content's relationship to the learning outcomes and offers guidance on possible approaches to delivery.
- *Assessment* – gives information about the evidence that learners must produce, together with any additional guidance if appropriate. This section should be read in conjunction with the assessment criteria.
- *Suggested resources* – lists resource materials that can be used to support the teaching of the unit, for example books, journals and websites.

Unit 1: Health and Safety in the Engineering Workplace

Unit reference number: T/600/0249

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

The aim of this unit is to give learners an understanding of the key features of health and safety legislation and regulations and how these are applied in engineering to ensure safe working conditions.

Unit introduction

The welfare of people working or operating within any engineering environment is of prime importance. All employees should expect to carry out their work in a safe manner that has no negative effect on their health and wellbeing.

Health and safety in the workplace is about measures designed to protect the health and safety of employees, visitors and the general public who may be affected by workplace activities. Safety measures are concerned with controlling and reducing risks to anyone who might be affected by these activities.

Health and safety is controlled largely by legislation and regulations and the law is continually being revised and updated. It is important that organisations are aware of these changes and keep up to date with developments.

This unit will give learners an understanding of hazards and risks associated with health, safety and welfare in an engineering workplace, the associated legislation and regulations and of their roles in complying with the related legal obligations. Learners will also be required to undertake full risk assessments and to appreciate the significant risks encountered in the workplace and the measures taken to deal with them. They will also study the principles of reporting and recording accidents and incidents, again within a legal context.

Essential resources

Learners will require access to a wide range of safety literature. Ideally, the centre will be able to provide access to health and safety legislation and learning materials on DVD.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Understand the key features of health and safety legislation and regulations	1.1	explain the key features of relevant regulations on health and safety as applied to a working environment in two selected or given engineering organisations	□ *Legislation*: (Health and Safety at Work etc Act 1974, Employment Act 2002, Factories Act 1961, Fire Precautions Act 1971) □ *Regulations*: (Employment Equality (Age) Regulations 2006, Management of Health and Safety at Work Regulations 1999, Provision and Use of Work Equipment regulations (PUWER) 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, Control of Noise at Work Regulations 2005, Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1995, Working Time Regulations 1998, Workplace (Health, Safety and Welfare) Regulations 1992, Health and Safety (First Aid) Regulations 1981, Supply of Machinery (Safety) (Amendment) Regulations 2005 (SI 2005/831)	□ For AC1.1 learners could research and explain key features of relevant regulations as applied to two separate working environments. It is suggested that four regulations could be considered across the two selected or given engineering organisations.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		1.2	describe the roles and responsibilities under current health and safety legislation and regulations, of those involved	□ Employers □ Employees □ Health and Safety Executive (HSE) (span of authority, right of inspection, guidance notes and booklets) □ Others (management, subcontractors, public, suppliers, customers, visitors)	□ For AC1.2 learners could describe the roles and responsibilities of those involved, under current health and safety legislation and regulations. The organisations selected could include learners' places of work, or a training workshop or machine shop environment. A combination of one electrical and one mechanical type would be most appropriate. An assignment could cover legislation and regulations. It is not expected that all the legislation and regulations listed would be covered, just those applicable to the given context. The roles and responsibilities of those involved could include employers, employees, the Health and Safety Executive and any one from the list of others within the unit amplification.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Know how to identify and control hazards in the workplace	2.1	describe the methods used to identify hazards in a working environment	□ *Within the workplace*: (methods to identify hazards, e.g. statements, analysis of significant risks, prediction of results or outcomes of those risks, use of accident data, careful consideration of work methods) □ *Working environment*: (consideration of the workplace and its potential for harm, e.g. confined spaces, working over water or at heights, electrical hazards, chemicals, noise)	□ For AC2.1 and AC2.2 learners could produce a risk assessment of a typical item or area of a working environment. This working environment could be the learner's workplace or one from the centre's own workshops. □ Whichever item or area is chosen, learners could identify a range of hazards, for example a machining operation or electrical assembly/wiring type activity could be used.
		2.2	describe how hazards which become risks can be controlled	□ Identification of trivial or significant risk □ Potential to cause harm □ Choosing appropriate control measures □ Electrical safety (identify and control hazards, cause of injury, effects of electricity on the body, circuit overloading) □ Mechanical safety (identify and control hazards, cause of injury, rotating equipment, sharp edges) □ Safety devices (residual current device (RCD), fuses, guards, fail safe, sensors)	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to carry out a risk assessment, identifying control measures	3.1	carry out a risk assessment on a typical item/area of the working environment	□ Items/area to be assessed (machine operation, work area) □ Five steps (principal hazards, who is likely to be injured/harmed, evaluate the risks and decide on adequacy of precautions, recording findings, review assessment)	□ For AC3.1 learners could use witness statements/observation records to show they are able to carry out a risk assessment on a typical item/area of the working environment. This working environment could be the learner's workplace or one from the centre's own workshops. □ AC3.2 could be achieved through an oral question and answer session after carrying out the risk assessment. A standard template can be used to capture the outcomes of the risk assessment as this is what would be found in normal company use.
		3.2	suggest suitable control measures after a risk assessment has been carried out and state the reasons why they are suitable	□ Control measures, e.g. use of recognised procedures, substances control, guarding, lifting assessments and manual handling assessments, regular inspection, use of Personal Protective Equipment (PPE), training of personnel, other personal procedures for health, safety and welfare	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Understand the methods used when reporting and recording accidents and incidents	4.1	explain the principles that underpin reporting and recording accidents and incidents	□ Why employers keep records of serious accidents, incidents and emergencies □ Responsibilities of competent persons □ Cost of accidents (direct, indirect, human consequences) □ Trends (major causes, fatal and serious injury, methods of classification, statistics)	□ For AC4.1 and AC4.2 learners could be given opportunities to investigate trends in an area they are interested in, which again may be an area similar to their workplace. An assignment could include a range of data given to each learner, some of which may have been researched and collected during the delivery of this part of the unit content.
		4.2	describe the procedures used to record and report accidents, dangerous occurrences or near misses.	□ Regulations on accident recording and reporting, Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1995, accident book, company procedures □ Procedures to deal with near misses or dangerous occurrences	

Information for tutors

Delivery

It is necessary to integrate health and safety at an early stage in all engineering units. Case studies/projects could be used for the delivery of this unit in an attempt to focus learners on the relationship between the process, the environment and health, safety and welfare.

Case studies might be based on a site where the learner is working. Where this is the case, learners may need to formulate and agree the scenario and the terms of reference for the case study or project with their tutor.

Alternatively, the unit could be taught using case studies that tutors can research from trade union material, the Health and Safety Executive (HSE) or local and national newspapers and radio stations. Indeed, the death of over 600 people every year at work is an illustration of the importance of effective education and training on health and safety. Many local HSEs would be very willing to give guidance and advice on accident prevention, along with statistics on health and safety performance.

The learning outcomes form a natural order for delivery. For learning outcome 1, the full range of legislation and Regulations can be made available, but learners could be asked to only research a given area and present their findings to the rest of the group, so that the whole group benefits from the exercise. All the areas of unit amplification are likely to be found easily on the internet.

Learning outcome 2 is about knowing how to identify hazards and could be covered through practical visits to workshops, companies or other areas. Before learning outcome 3 is delivered, it is appropriate to emphasise the differences between hazards and risks. The ways that risks are controlled could be dealt with in a practical way. Learners should be given opportunities to build their confidence in carrying out a risk assessment by practising this skill over a number of scenarios. This should allow them to carry out a risk assessment as an assessed activity. Photographs and drawings could be used to capture what they have done for future reference.

For learning outcome 4, learners could be taught about the principles involved when reporting and recording accidents and near misses. The pyramid of deaths to accidents to near misses should be emphasised. It is possible that research from learning outcome 1 might contain useful information regarding the requirements of RIDDOR. Visits to organisations to see their procedures will strengthen learners' understanding of this and all other health, safety and welfare aspects.

Note that the use of brackets in the unit amplification column is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all unit amplification included in brackets needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Cooke E, et al – *Level 3 BTEC National Engineering Student Book* (Pearson, 2010) ISBN 9781846907241

Boyce A – *Level 3 BTEC National Engineering Teaching Resource Pack* (Pearson, 2010) ISBN 9781846907265

Health and Safety Executive – *Essentials of Health and Safety at Work* (HSE Books, 2006) ISBN 9780717661794

Health and Safety Executive – *Health and Safety in Engineering Workshops* (HSE Books, 2004) ISBN 9780717617173

Website

www.hse.gov.uk	Health and Safety Executive website

Unit 2: Product Design

Unit reference number: A/502/5515

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

The aim of the unit is to give learners knowledge, skills and understanding of the product design process, from development of initial ideas, through to realisation of a product.

Unit introduction

The product designer combines creative skills and technical knowledge to produce tangible design outcomes. Product design is different from industrial design, which involves a broader range of design and engineering activities. The practice of product design has been assisted by the evolution of new software and digital tools that permit dynamic and realistic 2D visuals and 3D models, effective analysis of ideas and concepts and enhanced communication within a realistically condensed project timescale. This suits the designer, the design-studio manager, the manufacturer, the product marketer and, of prime importance, the client! Learners will discover that product design is the initial stage of any physical product, of any type. They will learn what good product design means to the global consumer in the continual drive for innovation, facilitation, sustainability and overall progress.

Learners will be introduced to the process of product design, involving the design brief, ideas generation, concept design and development, analysis, testing, revision and design realisation.

They will learn about the breadth of activities and stages involved in product design and the range of aesthetic, creative and technical skills required to undertake this primary stage of a potentially wider remit for research, development, strategic planning and product/industrial design for manufacture.

They will understand about other important features of product design, i.e. innovation, strategic enquiry, marketing, manufacture and be aware that good design runs in tandem with good communication, professional presentation and reflective practice.

Product design could be defined as the creation of every type of three-dimensional goods or objects, which will eventually be promoted and distributed through the commercial market.

Essential resources

Learners need access to a range of visual and technical resources. Workshops should be equipped to a good standard for work with a wide range of materials and should include equipment for model making and prototyping and machinery for fabrication including glueing, cutting, shaping, forming, fixing and finishing.

Suitable studio facilities should also be available for clean work, drawing, preparation and computer modelling.

A critique area with visual aids presentation resources would be invaluable for demonstrating ideas, development and outcomes to peers, tutors and (any) professional clients engaged with the product design brief.

Resources for research should include a permanent department collection of reference material, display facilities, access to a library and the internet, as well as computer facilities.

Learners need access to general design studios to be able to discuss and draw up their initial ideas. Depending on the scope of the project, they may need access to specialist computer resources if these are available in the centre. Learners also need access to a range of different processes and technology, again dependent upon the specific product design project.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Understand a product design brief	1.1	explain requirements, parameters and constraints in a product design brief	□ Analysis (establish briefing parameters, establish specific requirements and restrictions, discuss and determine definitions) □ Assess any ambiguous areas, aesthetic and functional criteria □ Discuss any revisions to agree briefing definitions	□ For AC1.1 learners could complete an initial appraisal of a sample (or hypothetical) product design brief. They could identify and clarify project parameters, documenting and recording sample briefing discussions in a format for review and analysis. □ Learners could then research additional sample briefs, developing an independent log of documents, diagrams and recordings, which could demonstrate useful analysis of a number of product design briefs.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Know how to communicate product design ideas and concepts	2.1	outline ideas and concepts through 2D and 3D visual communication	□ Source (others' visual styles, conventions, sketching, modeling) □ Research and develop ideas (relevant research, commercial examples, record ideas, written notes, sketches, concept models, ideas modification, consider alternative materials, aesthetic alterations, physical alterations, produce experimental or scale models) □ Record (ideas, written notes, sketches, concept models, consider materials, aesthetics)	□ For AC2.1 learners could select and analyse, as an individual or as part of a team, a product design brief which can be hypothetical or involve working with a client from industry. They could research historical and contemporary examples of product design in selected briefing context. □ Learners could produce and discuss initial ideas with peers (team) and specialist tutors in product design context and develop ideas, producing 2D sketches and 3D concept models, demonstrating use of materials, techniques and processes, for initial ideas presentation. □ Learners could then present ideas both internally to specialist tutors for ideas modification and then to professional a client, tutors and peers for review and feedback.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to develop product design proposals	3.1	demonstrate development of ideas and concepts	□ Visual communication (draft 2D computer-aided designs (CAD), hand-rendered technical, perspective, conceptual drawings, 3D physical and computer-generated scale, concept and expressive models) □ Ongoing analysis and evaluation (consider specific requirements, restrictions and definitions) □ Establish common understanding of any ambiguities □ Discuss, select, reject, progress initial ideas as appropriate propose, implement revisions □ Review (periodic presentation for consult with clients, end users, interested parties, colleagues, check), progress against project timelines, monitor resources	□ For AC3.1, learners could discuss the revisions and confirmation of any variations with specialist tutors, peers or professional clients and come to an agreement on the way forward. □ Learners could implement the development of revisions and any variations to demonstrate the results of testing and analysis to underpin the eventual design proposals.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to realise outcomes to a design brief	4.1	realise a product design outcome against a brief	□ Working independently or in association (cooperate with a proposal team, work as an individual to realise product outcome) □ Consult with team and others (verbally, using appropriate language, professional terms, conventions (visual and written) work as part of a team or as an individual to assemble, present proposed design outcome) □ Methodology (compile visual and digital communication, e.g. 2D computer-aided designs (CAD), hand-rendered technical, perspective, conceptual drawings, isometric representations, 3D physical and computer-generated scale, concept and expressive models, computer modeling) □ Presentation (compile professional presentations, develop 3D models, physical and computer generated scale, concept and expressive models, presentation to clients, end users, interested parties, colleagues) □ Strategy for review (check progress against project timelines, monitor resources, written analysis and evaluation of outcomes against briefing requirements)	□ For AC4.1 learners could present revised final design proposals which could include rendered visuals, scale representations of individual elements, a detailed model of final outcome, in context of demonstrating form, function, appropriation, sustainability and aesthetics. They could take guidance from peers, specialist tutors, through one to one, team critiques, to influence proposals, including health and safety references and design report, for working on product design briefs.

Information for tutors

Delivery

This unit provides tutors with the opportunity to engage learners in the analysis of simulated, realistic product design briefs. A range of hypothetical, realistic and/or professional client briefs should be included in the initial briefing analysis. This teaching and learning activity has a crucial, generic purpose across all art and design specialisms; if the range, content and guidance is set to reflect current practice, learners will experience developing confidence in analysing design briefs and understanding the parameters, constraints and outcomes in order to satisfy the briefing requirements – i.e. getting your design brief right!

Health and safety issues relating to studio, workshop and relevant specialist areas should be stressed throughout. Learners will need to be guided through current legislation such as the Disability Discrimination Act (DDA) and Building Regulations and Copyright Law.

It is important to ensure that learners are able to apply their understanding of the basic design process underpinning the product design brief. In particular, they must demonstrate the capacity to convert conceptual ideas expressed in 2D into an appropriate 3D form, and vice versa. Model making and computer modelling will be integral to the ideas and development stages of the product design process.

This unit relates closely to a number of 3D Design specialist units and professional specialist units as well as the core units relating to research and communicating the design process. Tutors may consider presenting an integrated programme, with the units running either concurrently or consecutively. It will be possible to cross-reference assessment evidence in this instance. Every opportunity should be taken to introduce learners to relevant industrial and commercial practice in order to expand their knowledge, understanding and experience of professional design practice.

Learning outcome 1 covers the analysis of project briefs. In the context of product design, it is essential that briefing goals are clearly defined before any ideas and concept development can begin. It is crucial that the briefing content is comprehensive and agreed as this reduces the risk of inappropriate outcomes. A range of project briefs should be offered to the leaner for investigation, analysis and conclusions. All evidence should be logged for effective recall.

Learning outcomes 2 and 3 are closely linked and cover the analysis and communication of ideas through appropriate 2D and 3D methods and media. Visual recording of ideas and concepts are integral to progress, design development and eventual outcomes. Tutors should pay particular attention to sketching and rendering and to the practical skills of model making and 3D computer modelling. Learners should also be encouraged to test their concepts regularly through prototypes, proofs, maquettes or other appropriate development and pre-production models and mock-ups.

Learning outcome 4 is closely linked to the three other unit learning outcomes and is based on the successful completion of the specific product design project. As with learning outcome 1, it is important that learners are encouraged to participate in analysing and questioning the effectiveness of their own and others' concepts and outcomes, working with a clear and proven reflective practice model to complete an appropriate design report.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Fiell C and Fiell P – *Industrial Design A-Z* (Taschen, 2006) ISBN 9783822850572

Ulrich K and Eppinger S – *Product Design and Development* (McGraw-Hill Education, 2007) ISBN 9780071259477

Urquiola P – *The International Design Yearbook 21* (Abbeville Press, 2007) ISBN 9780789209221

Journals and/or magazines

Design Council Magazine

Design Week

Websites

www.design-technology.org/furnituredesignindexpage.htm	Furniture design links
www.designcouncil.org.uk	Design Council
www.esciencenews.com/dictionary/product.design.projects	Science news about product design projects

Unit 3: Mathematics for Engineering Technicians

Unit reference number: A/600/0253

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit aims to give learners a strong foundation in mathematical skills.

Unit introduction

One of the main responsibilities of engineers is to solve problems quickly and effectively. This unit will enable learners to solve mathematical, scientific and associated engineering problems at technician level.

This unit enables learners to build on their existing knowledge, to use it in a more practical context for their chosen discipline.

Learning outcome 1 will develop learners' knowledge and understanding of algebraic methods, from a look at the use of indices in engineering to the use of the algebraic formula for solving quadratic equations.

Learning outcome 2 involves the introduction of the radian as another method of angle measurement, the shape of the trigonometric ratios and the use of standard formulae to solve surface areas and volumes of regular solids.

Learning outcome 3 requires learners to be able to represent statistical data in a variety of ways and calculate the mean, median and mode.

Finally, learning outcome 4 is intended as a basic introduction to the arithmetic of elementary calculus.

Essential resources

Learners will need to possess an electronic scientific calculator and have access to software packages that support understanding of the principles and their application to engineering.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to use algebraic methods	1.1	manipulate and simplify three algebraic expressions using the laws of indices and two using the laws of logarithms	□ Indices and logarithms: laws of indices: $a^m \times a^n = a^{m+n}$; $a^m/a^n = a^{m-n}$, $(a^m)^n = a^{mn}$; laws of logarithms: $\log A + \log B = \log AB$; $\log A^n = n \log A$; $\log A - \log B = \log(A/B)$ Common logarithms (base 10), natural logarithms (base e), exponential growth and decay.	□ AC1.1 could be assessed in the form of a short written test and could also include AC1.3.
		1.2	solve a linear equation by plotting a straight-line graph using experimental data and use it to deduce the gradient, intercept and equation of the line	□ *Linear equations and straight line graphs*: linear equations, e.g. $y = mx + c$; straight line graph (coordinates on a pair of labelled Cartesian axes, positive or negative gradient, intercept, plot of a straight line); experimental data, e.g. Ohm's law, pair of simultaneous linear equations in two unknowns.	□ For AC1.2, learners could be given a range of data sufficient for them to plot the graph and work out the gradient, intercept and the equation. Data forcing them to draw the line of best fit, as opposed to a set of points directly on the graphical line, might be most appropriate.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		1.3	factorise by extraction and grouping of a common factor from expressions with two, three and four terms respectively	□ *Factorisation and quadratics*: multiply expressions in brackets by a number, symbol or by another expression in a bracket; by extraction of a common factor, e.g. $ax + ay$, $a(x + 2) + b(x + 2)$; by grouping, e.g. $ax – ay + bx – by$; quadratic expressions, e.g. $ax^2 + bx + c$; roots of an equation, e.g. solving quadratic equations with real roots by factorisation, and by the use of formula.	□ AC1.3 could be assessed in the form of a short written test and could also include AC1.1.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Be able to use trigonometric methods and standard formula to determine areas	2.1	solve circular and triangular measurement problems involving the use of radian, sine, cosine and tangent functions	□ *Circular measure*: radian; degree measure to radians and vice versa; angular rotations (multiples of π radians); problems involving areas and angles measured in radians; length of arc of a circle ($s = r\theta$); area of a sector ($A = \frac{1}{2}r^2\theta$); sine, cosine and tangent functions.	□ For AC2.1, learners could be given a range of different values and assessed through an assignment or a short formal test. The problems given could collectively cover radian, sine, cosine and tangent functions. When considering the content part of this learning outcome it is important that these problems give the learner the opportunity to convert multiples of π radians to degrees and vice versa. The circular measurement problems could also cover the length of an arc and area of a sector as well as areas and angles measured in radians.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		2.2	sketch each of the three trigonometric functions over a complete cycle	□ *Triangular measurement*: functions (sine, cosine and tangent); sine and cosine wave over one complete cycle; graph of tan *A* as *A* varies from 0° to 360° (tan*A* = sin *A*/cos *A*); values of the trigonometric ratios for angles between 0° and 360°; periodic properties of the trigonometric function. □ the sine and cosine rule; practical problems, e.g. calculation of the phasor sum of two alternating currents, resolution of forces for a vector diagram.	□ For AC2.2, learners could sketch each of the three trigonometric ratios and this is probably best done as a classroom exercise.
		2.3	produce answers to two practical engineering problems involving the sine and cosine rule		□ AC2.3 could take the form of a written assignment where learners could produce answers to two practical engineering problems involving the sine and cosine rule (for example calculate the phasor sum of two alternating currents and evaluate the resultant, and calculate the angle between two forces).
		2.4	use standard formulae to find surface areas and volumes of regular solids for three different examples respectively	□ *Mensuration*: standard formulae to solve surface areas and volumes of regular solids, e.g. volume of a cylinder = $\pi r^2 h$, □ total surface area of a solid cylinder = $2\pi rh + 2\pi r^2$, □ volume of sphere = $4/3\pi r^3$, surface area of a sphere = $4\pi r^2$, volume of a cone = $1/3\pi r^2 h$, curved surface area of cone = πr x slant height.	□ For AC2.4, learners could calculate the surface areas and volumes for three different regular solids. This could be achieved through an assignment or perhaps by combining it with other criteria in a short formal test.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to use statistical methods to display data	3.1	collect data and produce statistical diagrams, histograms and frequency curves	□ *Data handling*: data represented by statistical diagrams, e.g. bar charts, pie charts, frequency distributions, class boundaries and class width, frequency table; variables (discrete and continuous); histogram (continuous and discrete variants); cumulative frequency curves.	□ An assignment could be used for AC3.1 where learners collect meaningful data (for example classification of workers within their company) and display this information using different graphical methods (for example bar charts). They also need to produce a histogram and plot frequency curves (for example resistance values of 100 resistors or external diameter of pins).
		3.2	determine the mean, median and mode for two statistical problems and explain the relevance of each average as a measure of central tendency	□ *Statistical measurement*: arithmetic mean; median; mode; discrete and grouped data.	□ For AC3.2, learners must provide evidence that they are able to determine and then explain the relevance of the mean, median and mode for a set of discrete and grouped data (for example time taken to produce components on a machine rounded to the nearest ten seconds and the 100 resistor values or diameters of pins from AC3.1). This could be done through an assignment.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to use elementary calculus techniques	4.1	apply the basic rules of calculus arithmetic to solve three different types of function by differentiation and two different types of function by integration	□ *Differentiation*: differential coefficient; gradient of a curve $y = f(x)$; rate of change; Leibniz notation (dy/dx); differentiation of simple polynomial functions, exponential functions and sinusoidal functions; problems involving evaluation, e.g. gradient at a point. □ *Integration*: integration as reverse of differentiating, basic rules for simple polynomial functions, exponential functions and sinusoidal functions; indefinite integrals; constant of integration; definite integrals; limits; evaluation of simple polynomial functions; area under a curve, e.g. $y = x(x - 3)$, $y = x^2 + x + 4$.	□ AC4.1 could be assessed through a short formal test, with learners being given a list of the standard differential coefficients and integrals to use.

Information for tutors

Delivery

Before starting this unit, learners should be able to demonstrate proficiency in basic mathematical concepts and the use of an electronic scientific calculator to carry out a variety of functions.

The learning outcomes are ordered logically and could be delivered sequentially. The use of algebraic methods is required before further skills can be developed and used within the unit. Much of learning outcome 1 can be practiced in pure mathematical terms, however tutors could emphasise where these methods would be applied in an engineering context. Obviously much practice in these methods will prove a valuable foundation for the rest of the unit.

Once learners have mastered most of these methods, learning outcome 2 gives opportunities to apply these skills when solving circular and triangular measurement problems. The application of these skills should reflect the context/area of engineering that learners are studying. Formulae do not need to be remembered but correct manipulation of the relevant formulae is very important in solving these problems. Learners should have plenty of practice when drawing graphs for learning outcome 1 and sketching trigonometric functions in learning outcome 2.

During the delivery of this unit there should be opportunities for learners to use statistical data that they have collected from engineering contexts or situations. It is much better to put statistics, required by learning outcome 3, in an engineering context than use generalities such as learners' height, etc.

Again, for learning outcome 4 opportunities to practise differentiation and integration could be given to ensure learners understand these activities within the range of the content and before they are given assessment activities. The range of these calculus techniques are listed within the content.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resource

Textbooks

Bird J – *Engineering Mathematics* (Elsevier Science & Technology, 2007) ISBN 9780750685559

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

Fuller A, Greer A, Taylor G W – *BTEC National Mathematics for Technicians* (Nelson Thornes, 2004) ISBN 9780748779499

Tooley M and Dingle L – *BTEC National Engineering*, 2nd Edition (Elsevier Science & Technology, 2007) ISBN 9780750685214

Unit 4: Ideas and Concepts in Art and Design

Unit reference number: K/502/5736

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit aims to broaden and deepen learner skills, knowledge and understanding of creative thinking, across contemporary and historical art and design, in order to inform their own practice.

Unit introduction

Ideas and concepts are the core of all creative art and design thinking. Innovation, imagination and intuition in the vocational world of art and design are essential for practitioners to create successful artwork, designs and products. Professionals use a wide range of intellectual, intuitive and perceptual skills in generating and developing their ideas. In order to secure commissions, practitioners must generate innovative ideas and be able to refine and present their ideas in exciting, persuasive and convincing ways.

They will investigate contextual sources to explore and analyse the creative ideas of different practitioners. Through this process learners will analyse the ideas and concepts used by practitioners for different purposes. This will involve studying language, images, artefacts, meaning, direct observation, perceptual sensitivity and the practitioners' own motivations in art and design.

Researching and analysing the thought processes of art and design practitioners and theorists should inform and inspire learners' own creative thinking in generating, developing and communicating their ideas and concepts. Learners will develop an understanding of their own innovative thought processes through carrying out activities and briefs that give them opportunities to explore possibilities within a range of ideas and concepts.

In working through this unit, learners will develop their communication skills. In preparing to progress to professional practice, learners must appreciate the need to create informed and stimulating presentations of their ideas for different audiences.

Essential resources

This is a core unit and is therefore mandatory across all specialist subject pathways. The resources needed for this unit will vary according to the specific technical and material demands of learners' work.

Essential resources include:

- *specialist workspaces*: e.g. studios, workshops, computer suites, video and film editing suites
- *materials, equipment and tools*: e.g. for 2D, 3D, time-based and associated materials, equipment and tools across all specialist areas
- *specialist staff*: e.g. for the different specialist pathways and this might also include technical support staff.

Visits to galleries, exhibitions, film reviews, plays, performance and live art, workshops, studios and advertising agencies could play an important role in designing assignments for this unit. Alternatively, bringing professional practitioners from art, design or media backgrounds in to talk about their work could help learners with the evidence requirements for this unit.

Learners should have access to a well-stocked learning centre, where resources include a broad coverage of ideas and concepts across the spectrum of art, craft and design. These should include written and visual materials for example books, journals, DVD, video. The collection should be sufficient to enable learners to source ideas and thinking in art craft and design, and to find a wide range of reference material for personal research. Learners will need access to specialist media and materials to complete this unit successfully.

Learners will also need to access information via other methods, such as the internet, and should also be encouraged to undertake visits to museums and galleries to research, select and record from relevant and appropriate work first hand.

There must be sufficient access to audio-visual and digital resources to enable learners to understand the range of possible presentation methods appropriate to their ideas and audiences.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Understand how ideas and concepts inform art and design work	1.1	compare ideas and concepts in art and design work	□ *References:* visual references; non-visual references; contemporary; historical; ideas e.g. Dada, Surrealism (psychoanalysis, automatic writing, advertising), Symbolists (visions, metaphor), Picasso (sketchbooks, development of ideas), religious belief (symbols, buildings, artefacts), Modernism (Bauhaus, architecture, literature, music, applied arts); art related e.g. sustainability, art and society, the media, performing arts, art and the environment, philosophy, religion. □ *Ideas:* influences e.g. visual, written, verbal, other artists, designers, visionaries, mythologies; communication e.g. meaning, concepts, semantics, metaphor, icon, ambiguity, equivalents.	□ Demonstrate the ability to identify and compare, as clearly as possible, a range of visual and verbal references to ideas and concepts in art and design, through notes, extended pieces of written texts, bibliographies and lists of references, annotated studies, recorded discussions, observation sheets, activity feedback and completed frameworks.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Know how to generate ideas	2.1	investigate ideas-generating techniques	□ *Investigating techniques:* e.g. mind-mapping, drawing, modelling, free association, first-hand observation, practical exploration, testing, free association, serial thinking, lateral thinking, word and image associations, instinct, intuition. □ *Ideas:* e.g. originality, feeling, meaning, communicating, innovative.	□ Learners could show evidence of investigations of how, for example, mental and practical activities such as mind-mapping, drawing, modelling and free association can generate ideas for art and design work.
3	Be able to generate and refine ideas in response to given briefs	3.1	generate and refine ideas in response to given briefs	□ *Analysis of brief:* e.g. clarifying demands, client needs, creative thinking, problem solving, action planning; constraints, reviewing ideas, response to feedback. □ *Generate and refine ideas:* e.g. notes, audio, video recordings, rough studies, mock-ups, lists, flow charts, mind maps, thumbnail sketches. □ *Context:* market e.g. client, audience, users, consumer, demographics, preferences, needs; environments; realisation e.g. site, scale, production, construction, installation, final product, quantities, timescale.	□ In order to achieve AC3.1, evidence could be through audio/visual recorded critical review sessions, observation sheets and witness statements, but also through results of practical activities, for example in ideas worksheets, model-making and samples or test pieces supported by annotated studies.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to communicate and present ideas and outcomes to different audiences	4.1	Communicate and present ideas and outcomes to different audiences	□ *Visualising techniques:* e.g. ideas worksheets, sample textile pieces, model-making, fly-throughs, maquettes, location shots, contact sheets, proofs, video clips, animations, storyboards, web pages. □ *Communicate ideas:* e.g. analyse, modify, adapt, refine, ideas, reviews, analysis, response, success, failure, working practices, materials, techniques, quality, aesthetics. □ *Presentation methods:* e.g. mounting, display, installation, event, forum, meeting, discussion, onscreen, projection, visual, written, notation, verbal, commentary, voice-over, soundtrack, music, performance, blogs, vlogs, podcasts. □ *Different audiences:* e.g. tutors, peers, audiences (specialist, non-specialist), age groups, professional practitioners, office workers, home workers, technicians, industrialists, managers, company directors, employees, self-employed, unemployed, employers, voluntary, private, public.	□ Learners could use varied presentation methods for different activities, using audio-visual equipment such as video, film, annotated slides that are of particular relevance to their ideas.

Information for tutors

Delivery

This unit aims to broaden and deepen learner understanding of what constitutes creative thinking, across contemporary and historical art and design, in order to inform their own practice.

Assignments covering the criteria for this unit might include research into others' work and investigating and comparing ideas and concepts in response to a range of briefs or themes for learners' chosen specialist pathways.

The specialist brief would encompass the criteria for ideas and concepts within one of the following:

- Fine Art
- Photography
- Textiles
- Interactive Media
- Graphic Design
- Design Crafts
- 3D Design
- Fashion and Clothing.

For this unit learners need to investigate techniques of creative thinking and generating of innovative ideas. Through this process learners will analyse the ideas and concepts used by artists for different purposes and, from their research, develop skills to generate and develop creative personal ideas. Learners will need to explore and broaden their use of visual, written and verbal communication skills in order to structure coherent presentations for different audiences.

The unit is the basis for learner understanding of the techniques employed in lateral thinking and, where relevant, could be integrated with other core and specialist unit assignments. Tutors might consider opportunities for individual and group discussions and activities in order to explore techniques of creative thinking.

Videos, demonstrations and presentations could be used to show good examples of innovation in contemporary and historical works, stimulating discussion, exploration and analysis. Learners could use these sessions as springboards for investigating and developing creative thinking techniques when generating ideas for set briefs or, later in the course, for learner-initiated briefs. Visits to galleries, designers' studios and workshops would provide vocational relevance for learners' understanding of the creative thought processes of professional practitioners.

An important part of this unit is to develop learners' innovative and imaginative abilities to generate and develop personal ideas. Practical activities such as techniques creating storyboards, thumbnails, annotated sketches, model-making or working on digitally manipulated designs should be planned alongside research and discussions.

For learning outcome 1, learners need to recognise and compare differences and similarities in the contexts and factors that influence and inform the development of ideas. It is vital that learners investigate examples of creative, innovative thinking processes. Learners will need to be taught how ideas and concepts can inform art and design work and how they can use this understanding to generate ideas for their own work. Learners will need opportunities to extend their linguistic skills to record, explain and analyse how the context of the examples they identify influences and informs their own ideas. Tutorials, group discussions, verbal and visual presentations, and using structured frameworks, might all contribute to the development of language and communication skills.

For learning outcome 2, learners will need to investigate techniques for ideas generation in the work of others and, through varied practical exercises, consider ways in which they can generate ideas for their own work.

For learning outcome 3, initial idea generation could be followed up by planned, interim critical evaluations, in groups or individually, of learners' initial ideas, leading to further practical activities. For example, worksheets, maquettes and video clips can be reviewed and modified in the light of critical review. When reviewing, learners will need to analyse the successes and/or failures of their working practices, their use of materials and techniques, and the quality and aesthetics of their work.

For learning outcome 4, planned opportunities for the development of presentation skills are essential to enable effective communication of learners' ideas. Presentation methods will include a range of different approaches suited to the ideas and intended audiences, for example mounting and display, presentation of visual and written work, verbal and visual presentation, and using bullet points and prompt cards. Methods could include combinations of digital and verbal presentation. Learners will need to research audience or client requirements in order to focus and select the appropriate information. Opportunities to practise the techniques of capturing audience interest and holding their attention will also be essential.

Learners should be made aware of the potential of this unit to enhance and develop their understanding of ideas and concepts in all areas of design.

Those working in time-based media may wish to explore more widely than the areas listed in the unit content section. Sequential and time lapse photography, stop animation, drawn animation and sound recording could also provide sources of evidence for presenting creative thinking techniques at pass, merit and distinction levels for this unit.

This unit will be assessed through observation, ongoing critique and submission of work undertaken in response to problem-solving exercises covering the three learning outcomes.

Evidence should include learners' analysis of problems, developmental work and ideas in response to given tasks. Documentation of contextual reference material, identification of key influences on the thinking process in design, and evaluations of learners' work and the thinking processes they have undertaken, will supplement evidence for the learning outcomes.

Learners should be able to explain clearly the techniques used in the development of their ideas through display and oral presentation.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Berger J – *Ways of Seeing* (Penguin Books/BBC, 2008) ISBN 9780141035796

Dormor R, Holmes S, Mott T, Schofied J, Thomas L, Wicks S, Wilson G – *Edexcel Level 3 BTEC National Art and Design Student Book* (Edexcel, 2010) ISBN 9781846906374

James K – *Bauhaus Culture* (University of Minnesota Press, 2006) ISBN 9780816646883

Kristian G and Schlempp-Ülker N – *Visualising Ideas* (Thames & Hudson, 2006) ISBN 9780500286128

Journals

Artists and Illustrators

Art Monthly

Art Review

British Journal of Photography

Contemporary

Crafts Magazine

Creative Review

Dazed and Confused Magazine

Design

Fashion Theory

Interior Design

Websites

www.artjournal.co.uk	Online guide to books and journals
www.craftscouncil.org.uk	The national development agency for contemporary crafts in the UK
www.creativehandbook.co.uk	Directory of creative practitioners
www.design-council.org.uk	The national strategic body for design
www.designmuseum.org	Design Museum, dedicated to contemporary design

www.fashion-era.com/C20th_costume_history

Links to resources on fashion

www.graphicdesign.about.com/arts/graphicdesign

Graphic design links

www.masters-of-photography.com	Photography links
www.symbols.com	Encyclopaedia of Western signs and ideograms
www.tate.org.uk	Tate galleries
www.tate.org.uk/podcasts	Links to podcasts from the Tate
www.vam.ac.uk	Victoria and Albert museum

Unit 5: Engineering Project

Unit reference number: T/600/0252

QCF level: 3

Credit value: 20

Guided learning hours: 120

Unit aim

This unit aims to enable learners to specify, plan and implement an engineering project and present its outcome.

Unit introduction

In the modern world engineers and technicians are often involved fully or in part with identifying problems and finding suitable solutions. These engineering problems may range from a very large project, such as designing and building a hydroelectric power station, to smaller projects, such as designing and producing a paper clip to keep notes secure. No matter how large or small, these problems need to be project managed in order to find engineered solutions. This unit will provide learners with opportunities to present their own solutions to engineering projects and should enable them to feel confident in carrying out project work within their chosen engineering discipline at the technician level.

The unit aims to integrate the knowledge and skills learners have gained throughout their programme of study, into a major piece of work that reflects the type of performance expected of an engineering technician. The project is intended to develop the learner's ability to identify and plan a course of action and follow this through to produce a viable solution/outcome to an agreed specification and timescale.

The end result of the project could be an engineering 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 project is also about developing the process skills necessary to carry out the project. Throughout the project learners will need to apply the technical skills developed in the other units in the qualification.

Essential resources

Learners will need access to a wide variety of physical resources, dependent on the type of project they pursue. Many of these resources are detailed within the other units in the qualification. There is also a need to provide some form of access to audio-visual aids as well as access to libraries and computer aided learning centres. Learners may also require access to workshops, laboratories and specialist catalogues and other documentation. Centres should also subscribe to engineering journals and stock other useful literature, specific to the branches of engineering being covered.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to specify a project, agree procedures and choose a solution	1.1	prepare and maintain project records from initial concepts through to solution that take account of and record changing situations	□ *Project records*: written e.g. notes, sketches, drawings; plans and modified plans; targets (setting, monitoring); use of planning tools e.g. paper based, electronic; recording initial concepts e.g. lists, notes, mind mapping, flow diagrams, sketches. □ *Initial concepts*: setting limits e.g. time, cost, feasibility, need; value–cost–benefit analysis; generating ideas e.g. group discussion, brainstorming, mind mapping; research techniques; lines of communication.	□ Learners will need to prepare and maintain project records from initial concepts through to solution that take account of and record changing situations. Evidence could be collected by tutors from the learner's logbook.
		1.2	prepare a project specification	□ *Specification*: type of project e.g. product design, plant layout/maintenance, production methods or similar engineering-related topics; technical information e.g. functionality, reliability, operational conditions, process capability, scale of operation, size, capacity, cost, style, ergonomics, present and future trends; health and safety issues; environmental and sustainability issues; quality standards and legislation; timescales; physical and human resource implications.	□ Learners prepare and submit a project specification for scrutiny in order to provide evidence for the achievement of AC1.2 (i.e. that they have produced a specification to an acceptable standard).

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		1.3	agree and prepare the procedures that will be followed when implementing the project	□ *Procedures*: roles and responsibilities e.g. decision making, budget planning and control; reporting methods; resource allocation and limits.	□ Learners could also include written evidence for the procedures (AC1.3) that they have agreed to follow, after discussion with their tutor, when implementing their project solution. Particular emphasis should be placed on ensuring that learners consider budgetary constraints and resource/time limitations.
		1.4	use appropriate techniques to evaluate three potential solutions and select the best option for development	□ *Techniques*: comparison methods e.g. statistical, graphical, quality and resource requirements/limitations, process capability, fitness-for-purpose; analysis e.g. cost–benefit, feasibility.	□ Evidence for the achievement of AC1.4, could be obtained from scrutiny of the learner's logbook, or again form part of the written project specification/interim report.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Be able to plan and monitor a project	2.1	outline the project solution and plan its implementation	□ *Planning*: long-term planning e.g. planners, charts and scheduling techniques (flow charts, Gantt charts, critical path methods, software packages); setting priorities; useful resource information e.g. human and physical.	□ Evidence of achievement will again be through the logbook. Tutors may also wish to record some of this performance as an observation record or use witness statements. The observations could take place when learners are using computer-aided or manual planning tools in the learning centre. □ Additional evidence for AC2.2 could come from the annotation of planning documentation or plans in the learner's logbook, which show the changing situations.
		2.2	monitor and record achievement over the life cycle of the project	□ *Monitoring*: monitor and record achievement e.g. use of logbook and/or diary for record keeping (names, addresses, telephone numbers, meeting dates, email and other correspondence lists); use of logbook e.g. for recording and analysing data or performance records, modifying/updating charts/planners, recording project goals and milestones, initial concepts, project solution technical decisions and information.	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to implement the project plan within agreed procedures	3.1	implement the plan and produce the project solution	□ *Implement*: proper use of resources e.g. equipment, tools, materials, within agreed timescale, use of appropriate techniques for generating solutions, adapting project plan where appropriate, maintaining appropriate records.	□ Learners who are engaged on design/build or physical testing/modification type projects on a system or component, will be spending most of their project implementation phase in workshops and/or laboratories. Therefore, tutors will need evidence from observation records and from the physical solution itself. Evidence of achievement of AC3.2 for those learners engaged in the production of a modified procedure/ service, will provide evidence of achievement via their logbook records, presentation and final written report.
		3.2	check the solution conforms to the project specification	□ *Checking solutions*: use of evaluative and analytical techniques e.g. graphs, matrix methods, statistics, Gantt charts, sequencing, scheduling, critical path methods, computer software packages.	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to present the project outcome	4.1	prepare and deliver a presentation to a small group outlining the project specification and proposed solution	□ *Presentation*: deliver a presentation to a small group e.g. 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 e.g. overhead transparencies, software packages and projectors, charts, models, video/DVD clips.	□ Evidence for AC4.1 could be obtained from a combination of hard copies of the presentation, such as handouts, slides etc and witness statements, together with the results of observation records from those present.
		4.2	present a written project report	□ *Project report*: 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 e.g. CAD, DTP, spreadsheets, databases, word processing.	□ The evidence for the achievement of AC4.2 could come from the written report itself. Clear guidelines as to what is expected need to be given to learners well before the submission of their report.

Information for tutors

Delivery

Centres will need to carefully consider how the unit content and required process skills are to be delivered. In particular, the administrative, planning, implementation and presentation skills and knowledge needs to be delivered before or in tandem with the time period allocated for the whole project. Some aspects of the content may be supported by other units in the programme, such as communications, mathematical and engineering principles and therefore may have already been covered. However, a large proportion of the process skills and knowledge will need to be delivered or reinforced during the early stages of project delivery. 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 opportunities to gain, use and practise these skills may well have already occurred in earlier units.

Tutors could start delivery of the unit by providing an overview of the whole project process and identifying the major milestones that need to be met in order to satisfy the assessment criteria. Providing learners with a route map/overview of what is required, when it is required and the project assessment strategy enables learners to formulate clear objectives and will aid their planning and delivery of the project outcome. The use and importance of the logbook as a source of evidence and living history of the project should also be emphasised and learners should be encouraged to open logbooks at this early stage and start to record events from the outset. A portfolio of primary research material should also be introduced at this stage, where information collected from the internet, literature and journals may be used for assessment evidence and as a source of reference when producing the final written report. 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.

Next, the process skills and knowledge could be delivered that enable learners to consider and select an appropriate project, after carrying out a feasibility study. Learners should be encouraged to try and select their own suitable project, or obtain one from their place of work/external customer, in preference to being given one by their tutor. Learners, who select their own project tend to have an interest in the subject and therefore require little encouragement to sustain progress throughout the whole life of the project and so produce a worthwhile outcome.

The advantages/disadvantages of a group project should also be clearly spelled out to learners, before they make their choice, with strong recommendations for them to undertake an individual project. If learners really desire to work in a team they will need to agree the topic with the other team members. It will also be essential to make sure that each team member has clear responsibilities and that everyone makes a contribution to the end result during every process/stage of the project. All individual team members must 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 (for example 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.

The delivery of the skills and knowledge associated with producing a project specification and selecting a project option could then be delivered, with sufficient time being allocated for learners to produce their specification and select their most favourable option. Learners will require varying degrees of help at this stage and tutors should carefully monitor individual learner progress and achievement.

In order for learners to achieve learning outcome 2, tutors will need to introduce or recap on the planning and monitoring techniques required to implement the project solution and monitor and record achievement over the life cycle of the project. This outcome could be delivered in a resource centre, where there is both library and computer access. Again, the amount of time spent with individual learners will vary according to their skill and proficiency in the use of planning and monitoring tools. Emphasis should be placed on the fact that the production of a long-term plan is not the end of the process and that there will need to be continual monitoring and modification/amendment of plans as events dictate.

The delivery of learning outcome 3, from the tutor's perspective, is mainly concerned with monitoring learner progress and acting as a point of reference for all things associated with the implementation and successful completion of the project solution. However, there is also a need to check with individual learners that they have planned their implementation process, in accordance with agreed procedures, particularly with respect to budgetary constraints and resource/time limitations. Throughout the unit, but particularly during the implementation phase in workshops or laboratories, the tutor should ensure that learners are made aware of all relevant health and safety issues, both for the implementation process and the product solution. 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. To ensure a satisfactory outcome/solution, learners will need to liaise with the customer and/or the project tutor and, if appropriate, other members of the team throughout all stages of the project. 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. Learners should also be encouraged to consider the environmental impact/sustainability issues of their project solutions and the effect of national/international standards and legislation.

The process skills and knowledge needed by learners to prepare and deliver a presentation and prepare and present a written report could be started while learners are still engaged with the implementation of their project solution. Learners may already have been introduced to the use of presentation aids and the format and methodology of report writing, so again the amount of formal input required for individual learners will vary. Tutors need to be aware of both group and individual needs and offer help and advice accordingly.

Learners should be able to use a range of computer software packages and electronic and manual equipment necessary to both prepare and present the presentation and final written report. Clear guidelines should be given to learners on the standards expected to meet the assessment criteria for learning outcome 4. Whether the presentation or the written report is presented first will depend on centre arrangements. It is often the case that the presentation is completed before the written report is submitted. This has the added advantage of being able to inform learners of any additional considerations that may need to be taken into account in order to improve the worth of the final project solution, as evidenced through the project report and any physical artefacts needed to demonstrate the solution. The importance of maintaining the logbook and having

the logbook and other portfolio evidence ready for final scrutiny should also be emphasised at some time before submission of the final report.

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.

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.

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.

Some examples of possible project outcomes for learners studying the aerospace pathway include:

- modification of an aeronautical product
- specifying, evaluating and/or designing an aeronautical system or service
- testing an aeronautical product.

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.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

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

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

Melton Trish – *Project Management Toolkit, the Basics for Project Success* (Butterworth-Heinemann, 2007) ISBN 9780750684408

Melton Trish – *Real Project Planning: Developing a Project Development Strategy* (Butterworth-Heinemann, 2007) ISBN 9780750684729

Project Management Institute – *A Guide to the Project Management Body of Knowledge* (Project Management Institute, 2008) ISBN 9781933890517

Smith N J – *Engineering Project Management* (Blackwell Publishing, 2007) ISBN 9781405168021

Tooley M and Dingle L – *BTEC National Engineering, 2nd Edition* (Newnes, 2007) ISBN 9780750685214

Unit 6: Properties and Applications of Engineering Materials

Unit reference number: R/600/0260

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit gives learners the opportunity to extend their knowledge of engineering materials, their properties and applications.

Unit introduction

In-depth knowledge of the structure and behaviour of engineering materials is vital for anyone who is expected to select or specify them for applications within the engineering industry. This unit will give learners an understanding of the structures, classifications and properties of materials used in engineering and will enable them to select materials for different applications.

The unit is appropriate for learners engaged in manufacturing and mechanical engineering, particularly where materials are sourced in the form of stock to be used in a production process. The unit covers a range of materials, some of which learners may not be familiar with initially.

This unit will enable learners to identify and describe the structures of metals, polymers, ceramics and composites and classify them according to their properties. Learners will also be able to describe the effects of processing on the behaviour of given materials. Smart materials whose properties can be altered in a controlled fashion through external changes – such as temperature and electric and magnetic fields – are also covered.

Learners will apply their understanding of the physical and mechanical properties of materials, design requirements, cost and availability to specify materials for given applications.

All materials have limits beyond which they will fail to meet the demands placed on them. The common modes of failure will be both demonstrated and described to enable learners to recognise where an informed choice can make the difference between the success or failure of a product.

Essential resources

Centres will need a selection of exemplar materials and components for viewing, tactile inspection and discussion. Degraded and failed component specimens will also be of value. Centres will also require access to equipment to conduct at least one destructive and one non-destructive test and related materials as specified in the unit content.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Know the structure and classification of engineering materials	1.1	describe the structure (including the atomic structure) associated with a given metal, polymer, ceramic, composite and smart material	□ *Atomic structure*: element; atom e.g. nucleus, electron; compound; molecule; mixture; bonding mechanisms e.g. covalent, ionic, metallic. □ *Structure of metals*: lattice structure; grain structure; crystals; crystal growth; alloying e.g. interstitial, substitutional; phase equilibrium diagrams e.g. eutectic, solid solution, combination; intermetallic compounds. □ *Structure of polymeric materials*: monomer; polymer; polymer chains e.g. linear, branched, cross-linked; crystallinity; glass transition temperature. □ *Structure of ceramics*: amorphous; crystalline; bonded. □ *Structure of composites*: particulate; fibrous; laminated Structure of smart materials: crystalline; amorphous; metallic.	□ The evidence to satisfy the pass criteria AC1.1 and AC1.2 could be achieved by means of a written assignment following a combination of tutor-led practical and theory sessions and individual research.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		1.2	classify given engineering materials as either metals or non-metals according to their properties	□ *Classification of metals*: ferrous e.g. plain carbon steel, cast iron (grey, white, malleable, wrought iron), stainless and heat-resisting steels (austenitic, martensitic, ferritic); non-ferrous e.g. aluminium, copper, gold, lead, silver, titanium, zinc; non-ferrous alloys e.g. aluminium-copper heat treatable – wrought and cast, non-heat-treatable – wrought and cast, copper-zinc (brass), copper-tin (bronze), nickel-titanium alloy. □ *Classification of non-metals (synthetic)*: thermoplastic polymeric materials e.g. acrylic, polytetrafluoroethylene (PTFE), polythene, polyvinyl chloride (PVC), nylon, polystyrene; thermosetting. □ polymeric materials e.g. phenol-formaldehyde, melamine-formaldehyde, urea-formaldehyde; elastomers; ceramics e.g. glass, porcelain, cemented carbides; composites e.g. laminated, fibre reinforced (carbon fibre, glass reinforced plastic (GRP)), concrete, particle reinforced, sintered; smart materials e.g. electro-rheostatic (ER) fluids, magneto-rheostatic (MR) fluids, piezoelectric crystals. □ *Classification of non-metals (natural)*: e.g. wood, rubber, diamond.	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Know material properties and the effects of processing on the structure and behaviour of engineering materials	2.1	describe mechanical, physical, thermal and electrical and magnetic properties and state one practical application of each property in an engineering context	□ *Mechanical properties*: strength (tensile, shear, compressive); hardness; toughness; ductility; malleability; elasticity; brittleness. □ *Physical properties*: density; melting temperature. □ *Thermal properties*: expansivity; conductivity. □ Electrical and magnetic properties: conductivity; resistivity; permeability; permittivity.	□ The evidence to satisfy the pass criteria AC2.1 could be achieved by means of a written assignment following a combination of tutor-led practical and theory sessions and individual research.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		2.2	describe the effects on the properties and behaviour of processing metals, polymers, ceramics and composites and of post-production use of smart materials	□ *Effects of processing metals*: recrystallisation temperature; grain structure e.g. hot working, cold working, grain growth; alloying elements in steel e.g. manganese, phosphorous, silicon, sulphur, chromium, nickel. □ *Effects of processing thermoplastic polymers*: polymer processing temperature; process parameters e.g. mould temperature, injection pressure, injection speed, mould clamping force, mould open and closed time. □ *Effects of processing thermosetting polymers*: process parameters e.g. moulding pressure and time, mould temperature, curing. □ *Effects of processing ceramics*: e.g. water content of clay, sintering pressing force, firing temperature. □ *Effects of processing composites*: fibres e.g. alignment to the direction of stress, ply direction; de-lamination; matrix/reinforcement ratio on tensile strength; particle reinforcement on cermets. □ *Effects of post-production use*: smart materials e.g. impact (piezoelectric), electric field (electro-rheostatic), magnetic field (magneto-rheostatic), temperature (shape memory alloys), colour change (temperature or viscosity).	□ For smart materials learners need to consider the effects on the properties of the materials use after production.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to use information sources to select materials for engineering uses	3.1	use information sources to select a different material for two given applications, describing the criteria considered in the selection process	□ *Information sources*: relevant standard specifications e.g. British Standards (BS), European Standards (EN), International Standards (ISO); material manufacturers' and stockholders' information e.g. data sheets, catalogues, websites, DVD. □ *Design criteria*: properties e.g. mechanical, physical, thermal, electrical and magnetic; surface finish; durability e.g. corrosion resistance, solvent resistance, impact resistance, wear resistance. □ *Cost criteria*: initial cost e.g. raw material, processing, environmental impact, energy requirements; processing e.g. forming, machining, casting, joining (thermal, adhesive, mechanical); quantity; mode of delivery e.g. bulk, just-in-time (JIT); recycling. □ *Availability criteria*: standard forms e.g. sheet and plate, bar-stock, pipe and tube, sectional, extrusions, ingots, castings, forgings, pressings, granular, powder, liquid.	□ To satisfy AC3.1 learners could apply the knowledge gained in meeting criteria AC1.1 to AC2.2. Written responses would satisfy these criteria.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Know about the modes of failure of engineering materials	4.1	describe the principles of the modes of failure known as ductile/brittle fracture, fatigue and creep	□ *Principles of ductile and brittle fracture*: effects of gradual and impact loading e.g. tensile, compressive, shear; effects of grain size; transition temperature; appearance of fracture surfaces. □ *Principles of fatigue*: cyclic loading; effects of stress concentrations e.g. internal, external; effects of surface finish; appearance of fracture surfaces. □ *Principles of creep*: primary; secondary; tertiary; effects of temperature; strain versus time curve; creep limit; effect of grain size; effect of variations in the applied stress.	□ To achieve AC4.1, learners could be given the opportunity to research modes of failure and degradation processes reflected in local conditions e.g. a marine environment, or, for employed learners, failure and degradation pertinent to their companies products.
		4.2	perform and record the results of one destructive and one non-destructive test method using one metal and one non-metallic material	□ *Tests*: destructive e.g. tensile, hardness, impact, ductility, fatigue, creep; non-destructive e.g. dye penetrant, ultrasonic, radiographic (x-ray, gamma ray), magnetic powder, visual.	□ AC4.2 could be achieved using a combination of practical and research activities involving tutor-led demonstrations of available laboratory tests. Learners could then carry out a series of tests and produce a written record of the test results. A witness statement could confirm the learners' involvement.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		4.3	describe a different process of degradation associated with each of metals, polymers and ceramics	□ *Degradation processes*: on metals e.g. oxidation, erosion, stress corrosion; on polymers e.g. solvent attack, radiation and ageing; on ceramics e.g. thermal shock, sustained high temperature.	□ To achieve AC4.3, learners could be given the opportunity to research modes of failure and degradation processes reflected in local conditions e.g. a marine environment, or, for employed learners, failure and degradation pertinent to their companies products.

Information for tutors

Delivery

Ideally, this unit could be delivered using a combination of practical demonstrations and investigative assignments.

To enable learners to understand both the mechanical and physical properties of engineering materials, workshop-based tests could be used to demonstrate the properties in a practical context. As an example, the differing effects of hot and cold working on the properties of copper and carbon steel could be demonstrated by lightly hammering specimens of both metals. By comparing the effort required to bend the cold-worked and untreated specimens, learners will gain first-hand experience of the effects of work hardening. If the specimens are then heat treated and cooled at different rates the results should provide evidence that can be evaluated during classroom-based theory sessions.

Delivery of the structure and properties of materials could be related to applications with which learners are familiar, giving flexibility in terms of the sources of evidence used to satisfy the grading criteria.

Tutors should ensure that learners are aware of the hazards and safe working practices associated with the use of heating equipment and common hand tools before supervising practical activities.

The learning outcomes are designed to be integrated across a range of assignments. For employed learners, assignments could be designed to reflect aspects of their work. The use of industrial visits could also be used to enhance learners' knowledge of the processes carried out by local companies.

Centres should have access to an appropriate range of specialist equipment to allow learners to perform both destructive and non-destructive tests. Learners will require instruction in the safe operation of such equipment. Radiographic and ultrasonic tests may not be readily available; however, if they are known to exist within a local industrial setting, centres may wish to arrange visits to enable learners to gain further experience.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Books

Darbyshire A – *Mechanical Engineering* (Newnes, 2008) ISBN 9780750686570

Higgins R – *Materials for Engineers and Technicians* (Newnes, 2006) ISBN 0750668504

Unit 7: Communications for Engineering Technicians

Unit reference number: M/600/0251

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

The aim of this unit is to give learners the opportunity to apply the wide range of communication methods used within engineering. These methods include visual representation, verbal and written skills, obtaining and using information and the use of information and communications technology (ICT).

Unit introduction

The ability to communicate effectively is an essential skill in all aspects of life. The usual methods of communication – speaking, reading and writing – are of no less importance to engineers. Engineers need to also convey technical information such as scale, perspective and standards of working. This unit will enable learners' to gain the skills needed to interpret and use engineering sketches/circuit/network diagrams to communicate technical information clearly in an engineering setting.

The drive towards greater use of information and communication technology is also important for engineering. The engineering industry is in the front line of working towards paperless communication methods, for example the electronic transfer of data from the concept designer straight to the point of manufacture.

This unit will provide the skills for employment in a wide range of engineering disciplines (for example manufacturing, maintenance, communications technology) in addition to providing a foundation for further study. It aims to develop learners' ability to communicate using a diverse range of methods. These include visual methods, such as drawing and sketching, and computer-based methods, such as two-dimensional (2D) computer-aided drawing (CAD) and graphical illustration packages. It will also develop learners' ability to write and speak within a framework of technology-based activities using relevant and accurate technical language appropriate to the task and the audience.

The unit will also introduce learners to a variety of skills and techniques to obtain and use information, for example the presentation of technical reports, business and technical data and the use of visual aids for presentations. Learners will also consider how to make best use of ICT within technological settings that are relevant to their programme of study or area of employment.

Essential resources

Access to information and communication technology resources (including the internet) is essential for the delivery of this unit, as is a well-stocked source of reference material.

Learners should be provided with a variety of sample written materials (letters, memos, technical reports, data sheets, catalogues) and sketches. Centres will need to provide access to appropriate presentation and graphics software (for example Microsoft PowerPoint, Visio), spreadsheet/database software (for example Microsoft Excel/Access) and computer hardware (for example scanners, printers, optical character recognition and speech recognition software, barcode readers).

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to interpret and use engineering sketches/circuit/ network diagrams to communicate technical information	1.1	interpret an engineering drawing/circuit/network diagram	□ *Interpret*: obtain information and describe features e.g. component features, dimensions and tolerances, surface finish; identify manufacturing/assembly/process instructions e.g. cutting lists, assembly arrangements, plant/process layout or operating procedures, electrical/electronic/communication circuit requirements; graphical information used to aid understanding of written or verbal communication e.g. illustrations, technical diagrams, sketches	□ For AC1.1, learners could show that they have had the opportunity to obtain information, describe features, identify instructions and make use of graphical information. For example, a task could be to work with written operating instructions that include supporting diagrams and sketches (2D and 3D).

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		1.2	produce an engineering sketch/circuit/network diagram	□ *Engineering sketches/circuit/network diagrams*: freehand sketches of engineering arrangements using 2D and 3D techniques e.g. components, engineering plant or equipment layout, designs or installations; electrical/electronic circuit diagrams, system/network diagrams; use of common drawing/circuit/network diagram conventions and standards e.g. layout and presentation, line types, hatching, dimensions and tolerances, surface finish, symbols, parts lists, circuit/component symbols, use of appropriate standards (British (BSI), International (ISO)).	□ For AC1.2, learners could show from their initial investigations, that they have produced their own drawing and sketches.
		1.3	use appropriate standards, symbols and conventions in an engineering sketch/circuit/network diagram		□ For AC1.3, learners' work could include identification and use of appropriate standards, symbols and conventions.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Be able to use verbal and written communication skills in engineering settings	2.1	communicate information effectively in written work	□ *Written work*: note taking e.g. lists, mind mapping/flow diagrams; writing style e.g. business letter, memo writing, report styles and format, email, fax; proofreading and amending text; use of diary/logbook for planning and prioritising work schedules; graphical presentation techniques e.g. use of graphs, charts and diagrams.	□ For AC2.1, learners' work could include evidence of note taking, the ability to use a specific writing style, proofread and amend text, use a diary/logbook and use graphical presentation techniques. It might be that all of these will not necessarily occur in a single task/activity. If not, it would be acceptable for a number of pieces of assessment evidence to be brought together to meet this criterion.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		2.2	communicate information effectively using verbal methods	□ *Verbal methods*: speaking e.g. with peers, supervisors, use of appropriate technical language, tone and manner; listening e.g. use of paraphrasing and note taking to clarify meaning; impact and use of body language in verbal communication.	□ For AC2.2, learners could demonstrate speaking and listening skills and an understanding of the impact and use of appropriate body language. The evidence for this could come from one task/activity so that all three aspects are being dealt with at the same time. This could be a meeting with either peers and/or a supervisor, or could come from a presentation delivered by the learner to a group.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to obtain and use engineering information	3.1	use appropriate information sources to solve an engineering task	□ *Information sources*: non-computer-based sources e.g. books, technical reports, institute and trade journals, data sheets and test/experimental results data, manufacturers' catalogues; computer-based sources e.g. inter/intranet, DVD-based information (manuals, data, analytical software, manufacturers' catalogues), spreadsheets, databases. □ *Use of information*: e.g. for the solution of engineering problems, for product/service/topic research, gathering data or material to support own work, checking validity of own work/findings.	□ For AC3.1, learners could identify and use appropriate information sources to solve an engineering task. It is essential that the information comes from both computer-based and non-computer-based sources. The evidence for this criterion could be as simple as suitably referenced work (a bibliography would not be sufficient). However, it would be preferable to have a record of the original source and a hard copy, annotated to show the information identified and used for the task (or at least an example of this process).

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to use information and communication technology (ICT) to present information in engineering settings	4.1	use appropriate ICT software packages and hardware devices to present information	□ *Software packages*: word processing; drawing e.g. 2D CAD, graphics package; data handling and processing e.g. database, spreadsheet, presentation package, simulation package such as electrical/electronic circuits, plant/process systems; communication e.g. email, fax, inter/intranet, video conferencing, optical and speech recognition system. □ *Hardware devices*: computer system e.g. personal computer, network, plant/process control system; input/output devices e.g. keyboard, scanner, optical/speech recognition device, printer, plotter. □ *Present information*: report that includes written and technical data e.g. letters, memos, technical product/service specification, fax/email, tabulated test data, graphical data; visual presentation e.g. overhead transparencies, charts, computer-based presentations (PowerPoint).	□ For AC4.1, learners could select and use appropriate ICT software packages and hardware devices to present information. Learners could use appropriate software to cover all the ICT applications listed in the content, i.e. there could be evidence of learners' selection and use of ICT for word processing, drawing, data handling and communication (such as email).

Information for tutors

Delivery

Learners should be given opportunities to develop their communication skills and enable them to add to the breadth and depth of their experience. In particular, emphasis should be placed on the development of 'hands-on' skills. Formative learning activities could be constructed around the following typical engineering tasks:

- reading and using an engineering sketches/circuit/network diagrams to obtain information/understand a task
- producing freehand sketches (2D and 3D) of engineering arrangements, for example a component, circuit, layout arrangement
- preparing a circuit/network diagram template (to include standard drawing/circuit/network information)
- using a 2D ICT-based software package to produce a detailed engineering component drawing or circuit/layout/network diagram (using the template produced previously)
- delivering a brief presentation (of eight minutes or more) using appropriate visual aids and responding appropriately to questions
- conducting a brief interview (lasting no longer than 15 minutes) with another learner and taking notes to summarise the outcome
- taking part in a group discussion to identify or share technical information within a set task
- preparing a letter to an engineering supplier requesting modifications to an engineered component
- preparing a brief technical report concerning a design modification
- producing a data sheet for a simple engineered product or service
- using information sources (literature, DVD and websites) to obtain data relating to an engineered product and summarise this in the form of a brief technical report
- sending and receiving email correspondence to convey engineering ideas and technical data.

The teaching and learning strategies used to deliver the unit must be set within an engineering context. There is a strong case for the delivery of this unit to be integrated, as far as possible, with other units in the programme rather than being taught as a stand-alone unit. This would ensure that the skills required (producing drawings and documents, finding, using and presenting information, using ICT) are developed as they are needed. By not adopting an integrated approach there is a risk that it could lead to a loss of relevance and the need for learners to undertake unnecessary learning development and assessment activities.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Books

Ernie Cooke E, Jones R, Mantovani B and Roberts D – *Level 3 BTEC National Engineering Student Book* (Pearson, 2010) ISBN 9781846907241

Boyce A – *Level 3 BTEC National Engineering Teaching Resource Pack* (Pearson, 2010) ISBN 9781846907265

Tooley M and Dingle L – *BTEC National Engineering: Core units for all BTEC National Engineering pathways* (Newnes, 2007) ISBN 9780750685214

Unit 8: Mechanical Principles and Applications

Unit reference number: F/600/0254

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit gives learners the opportunity to extend their knowledge of mechanical principles and to apply them when solving engineering problems.

Unit introduction

The use and application of mechanical systems is an essential part of modern life. The design, manufacture and maintenance of these systems are the concern of engineers and technicians who must be able to apply a blend of practical and theoretical knowledge to ensure that systems work safely and efficiently. Science underpins all aspects of engineering and a sound understanding of its principles is essential for anyone seeking to become an engineer.

The selection and use of engineering materials builds on the principles laid down by the scientists Hooke and Young. The laws of motion, put forward by Sir Isaac Newton, underpin the design of dynamic engineering systems ranging from domestic appliances through motor vehicles to spacecraft. Similarly, the design of internal combustion engines and gas turbines is based on the principles and laws that were put forward by Boyle, Charles and Joule.

This unit aims to build upon the knowledge gained at GCSE and BTEC First Diploma level. Learning outcome 1 will introduce learners to the behaviour of loaded engineering materials and the analysis of a range of static engineering systems that will include the application of Hooke's Law and Young's modulus. Learning outcome 2 will extend learners' knowledge of dynamic systems through the application of Newtonian mechanics. It will also consider the storage and transfer of energy that is often involved in the operation of mechanical systems. Learning outcomes 3 and 4 seek to lay the foundation for future work in applied thermodynamics and fluid mechanics. In particular, they will deal with the effects of heat transfer, the expansion and compression of gases and the characteristic behaviour of liquids at rest and in motion.

This unit provides a basis for further work in the areas of mechanical principles, engineering thermodynamics, fluid mechanics and other related applications of engineering science.

Essential resources

There are no essential resources required for this unit. Centres should wherever provide access to laboratory facilities with a sufficient range of investigation and demonstration equipment wherever possible. In particular, tensile testing equipment, dynamics trolleys, linear expansivity apparatus, apparatus to determine density and apparatus for verification of Boyle's and Charles' laws would be of significant value.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to determine the effects of loading in static engineering systems	1.1	calculate the magnitude, direction and position of the line of action of the resultant and equilibrant of a non-concurrent coplanar force system containing a minimum of four forces acting in different directions	□ *Non-concurrent coplanar force systems*: graphical representation e.g. space and free body diagrams; resolution of forces in perpendicular directions e.g. $F_x = F\cos\theta$, $F_y = F\sin\theta$; vector addition of forces, resultant, equilibrant, line of action; conditions for static equilibrium ($\Sigma F_x = 0$, $\Sigma F_y = 0$, $\Sigma M = 0$).	□ For AC1.1, learners could produce space and free body diagrams, resolve forces horizontally and vertically and take moments of the forces about some suitable reference point. The magnitude and direction of the resultant force and the position of its line of action could then be found through vector addition, application of Pythagoras' theorem and consideration of the resultant turning moment.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		1.2	calculate the support reactions of a simply supported beam carrying at least two concentrated loads and a uniformly distributed load	□ *Simply supported beams*: conditions for static equilibrium; loading (concentrated loads, uniformly distributed loads, support reactions).	□ For AC1.2, learners could demonstrate the resolution of forces applied at an angle to the beam and calculation of the magnitude and directions of the support reactions.
		1.3	calculate the induced direct stress, strain and dimensional change in a component subjected to direct uniaxial loading and the shear stress and strain in a component subjected to shear loading	□ *Loaded components*: elastic constants (modulus of elasticity, shear modulus); Hooke's Law; loading (uniaxial loading, shear loading); effects e.g. direct stress and strain including dimensional change, shear stress and strain, factor of safety.	□ For AC1.3, learners could calculate the direct stress, direct strain and the accompanying dimensional change in a directly loaded component. They could also calculate the shear stress and shear strain in a component or material subjected to shear loading.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Be able to determine work, power and energy transfer in dynamic engineering systems	2.1	solve three or more problems that require the application of kinetic and dynamic principles to determine unknown system parameters	□ *Kinetic parameters*: e.g. displacement (s), initial velocity (u), final velocity (v), uniform linear acceleration (a) Kinetic principles: equations for linear motion with uniform acceleration ($v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$, $s = \frac{1}{2}(u + v)t$). □ *Dynamics parameters*: e.g. tractive effort, braking force, inertia, frictional resistance, gravitational force, momentum, mechanical work ($W = Fs$), power dissipation (Average Power = W/t, Instantaneous Power = Fv), gravitational potential energy ($PE = mgh$), kinetic energy ($KE = \frac{1}{2}mv^2$). □ *Dynamic principles*: Newton's laws of motion, D'Alembert's principle, principle of conservation of momentum, principle of conservation of energy.	□ For AC2.1, learners could solve at least three dynamic system tasks to ensure that the range of kinetic and dynamic principles is applied. Centres should not fragment the application of kinetic and dynamic principles to the extent that they over simplify the problems. It is the interrelationships between the kinetic and dynamics principles that are as important as the use of any single equation.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to determine the parameters of fluid systems	3.1	calculate the resultant thrust and overturning moment on a vertical rectangular retaining surface with one edge in the free surface of a liquid	□ *Thrust on a submerged surface*: hydrostatic pressure, hydrostatic thrust on an immersed plane surface ($F = \rho g A x$); centre of pressure of a rectangular retaining surface with one edge in the free surface of a liquid.	□ For AC3.1, learners could calculate the resultant thrust and overturning moment on a rectangular retaining surface, examples of which are listed in the delivery section.
		3.2	determine the upthrust on an immersed body	□ *Immersed bodies*: Archimedes' principle; fluid e.g. liquid, gas; immersion of a body e.g. fully immersed, partly immersed, determination of density using floatation and specific gravity bottle methods.	□ For AC3.2, learners could calculate the up-thrust on a totally immersed body using Archimedes' principle.
		3.3	use the continuity of volume and mass flow for an incompressible fluid to determine the design characteristics of a gradually tapering pipe	□ *Flow characteristics of a gradually tapering pipe*: e.g. volume flow rate, mass flow rate, input and output flow velocities, input and output diameters, continuity of volume and mass for incompressible fluid flow.	□ For AC3.3, learners could consider the design of a gradually tapering pipe to suit given dimensional and flow constraints.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to determine the effects of energy transfer in thermodynamic systems.	4.1	calculate dimensional change when a solid material undergoes a change in temperature and the heat transfer that accompanies a change of temperature and phase	□ *Heat transfer*: heat transfer parameters e.g. temperature, pressure, mass, linear dimensions, time, specific heat capacity, specific latent heat of fusion, specific latent heat of vaporisation, linear expansivity; phase e.g. solid, liquid, gas; heat transfer principles e.g. sensible and latent heat transfer, thermal efficiency and power rating of heat exchangers; linear expansion.	□ For AC4.1, learners could determine the dimensional change in an engineering component that accompanies a change in temperature, and the sensible and latent heat transfer that accompanies a change of temperature and phase in a substance.
		4.2	solve two or more problems that require application of thermodynamic process equations for a perfect gas to determine unknown parameters of the problems.	□ *Thermodynamic process equations*: process parameters e.g. absolute temperature, absolute pressure, volume, mass, density; Boyle's law (PV = constant), Charles's law (V/T = constant), general gas equation (PV/T = constant), characteristic gas equation (PV = mRT).	□ For AC4.2, learners could involve the range of thermodynamic process equations applicable to the expansion and compression of an ideal gas.

Information for tutors

Delivery

Although the unit content can be delivered in any order, it might be advisable to follow the order of the learning outcomes. Revision of previous work on the polygon of forces may be necessary in learning outcome 1 before applying the principles of vector addition and force resolution to non-concurrent coplanar force systems. Likewise, the conditions for static equilibrium may need to be revised before applying them to the calculation of simply supported beam reactions. Practical demonstrations using force boards and balanced beam apparatus could be used to support the theoretical concepts.

After defining elasticity, the validity of Hooke's law might also be demonstrated as a practical exercise before introducing learners to the concepts of stress, strain and the elastic constants. If available, use should be made of tensile testing equipment and a suitable extensometer to determine modulus of elasticity and tensile strength. Where appropriate, the calculation of stress should be accompanied by determination of the factor of safety in operation. Learners should however be made aware that the presence of stress concentrations could affect its validity.

The revision of motion parameters, for learning outcome 2, should be followed by derivation of the equations for uniform linear motion using distance versus time and velocity versus time graphs. Newton's laws of motion are an essential introduction to the understanding of momentum and inertia, leading to the application of D'Alembert's principle in the solution of dynamic problems. In its simplest form, D'Alembert's principle states that if the internal inertial reaction to the acceleration or retardation of a body (ie the product mass x acceleration given by Newton's second law) is imagined to be an external force, then the body can be treated as though it were in static equilibrium under the action of a system of external forces. A free body diagram can then be drawn to aid the solution of a dynamic problem. The diagram might also contain frictional resistance F_f and some component of weight mg sinθ, if the body is on an incline. The resultant force F (tractive effort or braking force) is then the vector sum of these three, i.e. $F = ma + F_f + mg\sin\theta$.

The application of D'Alembert's principle is thus the application of Newton's second and third laws of motion with the inertial reaction ma, considered as an external force. Problems should be set which involve consideration of inertia, friction and gravity when calculating tractive effort, braking force, work and power. These might include the motion of a vehicle on an incline, the operation of a lift or hoist, or the motion of a machine slide or worktable.

The relationship between work done and the form of energy stored should be clearly explained when deriving expressions for gravitational potential energy and kinetic energy. A clear distinction should be made between the principle of conservation of momentum and the principle of conservation of energy together with their applications. If time and facilities permit, the use of dynamics, trolleys and timers can be used to demonstrate the principle of conservation of momentum. Problems involving bodies in collision, separation of space vehicles and the operation of pile drivers and drop hammers might be used to illustrate application of the two principles. Dynamics problems that have been previously solved using the equations of motion, D'Alembert's principle and Newton's laws

could be revisited and solved using energy considerations. Learners will then be aware that this is an alternative and equally valid approach to the solution of dynamics problems and will be able to compare and evaluate the two methods.

On starting learning outcome 3, revision of previous work on hydrostatic pressure will lead to calculation of thrust on immersed plane surfaces. The depth of the centre of pressure for a rectangular retaining wall with one edge in the free surface of the liquid should be derived from first principles using integration. This can then be applied in the solution of problems such as those involving retaining walls, sluice gates and lock gates. Knowledge of the second moment of area is not required for this level of problem. This could be followed by an explanation of Archimedes' principle and calculation of up-thrust on immersed bodies. The determination of density by floatation and use of a specific gravity bottle should be explained and if possible, demonstrated. Finally, steady incompressible flow through tapering pipes can be considered with problems to determine flow velocities, flow rates and pipe dimensions using the equations for continuity of volume and mass flow.

It will be beneficial to revise and define the Celsius and absolute scales of temperature and the concept of absolute zero of temperature before starting the heat transfer content of learning outcome 4. This could begin with the definition of linear expansivity and the calculation of dimensional change that accompanies a change in temperature for a substance whose movement is unrestricted. Learners should be made aware that thermal stress would be induced where a body is constrained in some way. If time and facilities exist it may be beneficial to include a practical investigation to determine the linear expansivity of a material. The definition of specific heat capacity and specific latent heat of fusion and vaporisation could follow, with the solution of problems involving the calculation of sensible and latent heat transfer and heat transfer rates.

The remaining content of learning outcome 4 is concerned with the expansion and compression of gases. This essentially involves an explanation of the gas laws and, if possible, their experimental verification. The general gas equation PV/T=constant, can be derived from a consideration of expansion according to Boyle's and Charles' laws leading to statement of the characteristic gas equation PV = mRT. Learners should also be made aware that this could be manipulated to give expressions for the density and specific volume of a gas. It is sufficient at this stage to quote the value of the characteristic gas constant R for a given gas without reference to the universal gas constant or the specific heat capacities of the gas.

Learners should be made aware of the limitations of the gas equations when applied to real gases and particularly to vapours. Problems might include the expansion and compression of a gas in an engine cylinder bringing in the calculation of initial and final volumes from bore, stroke and compression ratio data, making use of all of the ranged equations.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Books

Ernie Cooke E, Jones R, Mantovani B and Roberts D – *Level 3 BTEC National Engineering Student Book* (Pearson, 2010) ISBN 9781846907241

Boyce A – *Level 3 BTEC National Engineering Teaching Resource Pack* (Pearson, 2010) ISBN 9781846907265

Bolton W – Engineering Science (Newnes, 2006) ISBN 9780750680837

Unit 9: Electrical and Electronic Principles

Unit reference number: J/600/0255

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit aims to give learners an understanding of the underlying physical principles on which electrical and electronic devices and circuits depend.

Unit introduction

The modern world relies on electrical and electronic devices – from mobile telephones to jet aeroplanes, these devices have had an enormous impact on the way we live today. Without early engineers such as Faraday and Lenz, who studied the then new concept of electricity, many of the inventions we now take for granted would not have been developed.

The unit starts by developing and extending learners' understanding of fundamental electrical and electronic principles through analysis of simple direct current (DC) circuits. Learners are then taken through the various properties and parameters associated with capacitance and inductance, before finally considering the application of single-phase alternating current (AC) theory. The unit will encourage learners to take an investigative approach through practical construction, measurement and testing of circuits and, where applicable, the use of computer-based circuit analysis and simulation.

For learners wishing to follow an electrical/electronic programme this unit is an essential building block that will provide the underpinning knowledge required for further study of electrical and electronic applications.

Essential resources

It is essential that learners have access to a well-equipped electrical and electronics laboratory with up-to-date electrical/electronic instruments such as digital and analogue multimeters, function generators and oscilloscopes. Centres will also need to provide appropriate circuit components, as identified in the unit content, together with the means to physically construct circuits.

With the increased use of computer-based methods for circuit design and simulation, centres are strongly advised to consider the provision of suitable hardware and software.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to use circuit theory to determine voltage, current and resistance in direct current (DC) circuits	1.1	use DC circuit theory to calculate current, voltage and resistance in DC networks	□ *DC circuit theory*: voltage e.g. potential difference, electromotive force (emf); resistance e.g. conductors and insulators, resistivity, temperature coefficient, internal resistance of a DC source; circuit components (power source e.g. cell, battery, stabilised power supply; resistors e.g. function, types, values, colour coding; diodes e.g. types, characteristics, forward and reverse bias modes); circuit layout (DC power source, resistors in series, resistors in parallel, series and parallel combinations); Ohm's law, power and energy Formulae e.g. V = IR, P = IV, W = Pt, application of Kirchhoff's voltage and current laws.	□ To calculate current, voltage and resistance in DC networks, learners could achieve this by using a paper-based or computer-based method. However, it is essential that centres combine any testing of this sort with practical hands-on experience of real circuits and components. This could be achieved by prototyping circuits using simulation software to establish theoretical circuit values, followed by learners building the circuit and physically checking theory against actual results by measurement.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		1.2	use a multimeter to carry out circuit measurements in a DC network	□ *DC networks*: networks with one DC power source and at least five components e.g. DC power source with two series resistor and three parallel resistors connected in a series parallel arrangement; diode resistor circuit with DC power source, series resistors and diodes.	□ Learners will require process evidence, i.e., it will need to be observed by the tutor during relevant practical activities. Tutors could capture this evidence by using an appropriate record of observation and oral questioning of each learner during the practical activities used for delivery.
		1.3	compare the forward and reverse characteristics of two different types of semi-conductor diode	□ *Measurements in DC circuits*: safe use of a multimeter e.g. setting, handling, health and safety; measurements (circuit current, voltage, resistance, internal resistance of a DC power source, testing a diode's forward and reverse bias).	□ Learners will require the use of a multimeter, power supply, ammeter with shunt, and a switch resistor box with evidence captured as in 1.2 above.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Understand the concepts of capacitance and determine capacitance values in DC circuits	2.1	describe the types and function of capacitors	□ *Capacitors*: types (electrolytic, mica, plastic, paper, ceramic, fixed and variable capacitors); typical capacitance values and construction (plates, dielectric materials and strength, flux density, permittivity); function e.g. energy stored, circuits (series, parallel, combination); working voltage.	□ Learners could describe the full range of types of capacitors (electrolytic, mica, plastic, paper, ceramic, fixed and variable) including typical capacitance values, construction (plates, dielectric materials and strength, flux density, permittivity), their function and working voltages.
		2.2	carry out an experiment to determine the relationship between the voltage and current for a charging and discharging capacitor	□ *Charging and discharging of a capacitor*: measurement of voltage, current and time; tabulation of data and graphical representation of results; time constants.	□ Learners could carry out a laboratory experiment to investigate the charging and discharging of a capacitor through a resistor. A simple but effective way of doing this would be to use a power supply unit, a 500µF electrolytic capacitor, a stopwatch or clock and an AVO type multimeter, using the internal resistance of the meter as the resistor.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		2.3	calculate the charge, voltage and energy values in a DC network for both three capacitors in series and three capacitors in parallel	□ *DC network that includes a capacitor*: e.g. DC power source with two/three capacitors connected in series, DC power source.	□ Learners could be given a worksheet with a series of problems to cover this AC.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Know the principles and properties of magnetism	3.1	describe the characteristics of a magnetic field	□ *Magnetic field*: magnetic field patterns e.g. flux, flux density (B), magneto motive force (mmf) and field strength (H), permeability, B/H curves and loops; ferromagnetic materials; reluctance; magnetic screening; hysteresis.	□ Learners could use an OHP to demonstrate the characteristics of magnetic fields by using magnets and iron filings. Learners could sketch the results and then make appropriate comparisons with expected theoretical results.
		3.2	describe the relationship between flux density (B) and field strength (H)		□ Learners could explain the relationship between flux density (B) and field strength (H) with particular emphasis on BH curves and the use of different materials such as silicon iron and mild steel.
		3.3	describe the principles and applications of electromagnetic induction	□ *Electromagnetic induction*: principles e.g. induced electromotive force (emf), eddy currents, self and mutual inductance; applications (electric motor/generator e.g. series and shunt motor/generator; transformer e.g. primary and secondary current and voltage ratios); application of Faraday's and Lenz's laws.	□ Learners could provide basic explanations of the principles and concepts of electromagnetic induction such as the movement of a conductor within a magnetic field.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to use single-phase alternating current (AC) theory	4.1	use single phase AC circuit theory to determine the characteristics of a sinusoidal AC waveform	□ *Single phase AC circuit theory*: waveform characteristics e.g. sinusoidal and non-sinusoidal waveforms, amplitude, period time, frequency, instantaneous, peak/peak-to-peak, root mean square (rms), average values, form factor; determination of values using phasor and algebraic representation of alternating quantities e.g. graphical and phasor addition of two sinusoidal voltages, reactance and impedance of pure R, L and C components.	□ Learners could use a multimeter and an oscilloscope to make appropriate comparisons of frequency, maximum and rms values.
		4.2	use an oscilloscope to measure and determine the inputs and outputs of a single phase AC circuit.	□ *AC circuit measurements*: safe use of an oscilloscope e.g. setting, handling, health and safety; measurements (periodic time, frequency, amplitude, peak/peak-to-peak, rms and average values); circuits e.g. half and full wave rectifiers.	

Information for tutors

Delivery

The four learning outcomes are linked and the delivery strategy should ensure that these links are maintained. Learning outcome 1 is the most likely starting point for delivery as it will establish much of the underpinning knowledge and skills required for the remaining learning outcomes. The unit could be delivered through a combination of theory lessons and demonstrations, reinforced through practical work in an electrical science laboratory/workshop. It is important that learners have a thorough understanding of circuit theory if they are to be able to recognise, handle and select relevant components (for example power sources, resistors, diodes).

Initially, delivery could use paper-based or computer-based exercises (for example, calculate the required value of a second resistance in a series circuit to give a current flow of 2A with a 6V power source). However, even at this stage it may be beneficial to introduce learners to real circuit components. The learners' ability to lay out circuits is an important part of this learning outcome and will support the other outcomes of the unit. Most centres will probably start with paper-based methods of drawing simple circuits (for example power source and series/parallel combination of resistors such as voltage and current divider circuits). It is likely that centres will move on to computer simulation and the use of real circuits/components, using either 'bread boarding' techniques or soldered circuits.

Learners should be given the opportunity to practise using the formulae identified in the unit content but are not required to memorise them. However, they should be expected to select the most appropriate formulae to determine the required circuit values of current, voltage or resistance. In addition, learners should have the confidence to transpose equations to meet their needs (for example use Ohm's law $V = IR$ and the power equation $P = IV$ to arrive at $P = I^2R$, use $R = R1+R2$ to arrive at $R1 = R – R2$). Clearly, the ability to transpose formulae is a mathematical skill and tutors will need to ensure that appropriate support is provided during both the delivery of this learning outcome and the unit as a whole.

Wherever possible, centres should enable learners to experience a range of multimeters that reflect typical and current industry usage. It would not be appropriate to use only computer-based simulation packages. Tutors should ensure the safe use of multimeters and an awareness of their use in a laboratory/workshop and industrial setting.

The use of computer-based software packages for analysis and simulation of electrical circuits together with practical laboratory work will help to corroborate theoretical results.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Books

Ernie Cooke E, Jones R, Mantovani B and Roberts D – *Level 3 BTEC National Engineering Student Book* (Pearson, 2010) ISBN 9781846907241

Boyce A – *Level 3 BTEC National Engineering Teaching Resource Pack* (Pearson, 2010) ISBN 9781846907265

Unit 10: Further Mathematics for Engineering Technicians

Unit reference number: H/600/0280

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit aims to enhance learners' knowledge of the mathematical principles used in engineering.

Unit introduction

Mathematics is an essential tool for any electrical or mechanical engineering technician. With this in mind, this unit emphasises the engineering application of mathematics. For example, learners could use an integral calculus method to obtain the root mean square (RMS) value of a sine wave over a half cycle.

The first learning outcome will extend learners' knowledge of graph plotting and will develop the technique of using a graph to solve (find the roots of), for example, a quadratic equation.

Learning outcome 2 involves the use of both arithmetic and geometric progressions for the solution of practical problems. The concept of complex numbers, an essential tool for electrical engineers considering, is also introduced.

Learning outcome 3 considers the parameters of trigonometrical graphs and the resultant wave when two are combined. The use of mathematical formulae in the latter half of this learning outcome enables a mathematical approach to wave combination to be considered.

Finally, in learning outcome 4, calculus techniques are further developed and used to show their application in engineering.

Essential resources

Learners will need to use an electronic scientific calculator and have access to software packages that support the concepts and principles and their application to engineering.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to use advanced graphical techniques	1.1	use a graphical technique to solve a pair of simultaneous linear equations	□ *Advanced graphical techniques*: graphical solution of a pair of simultaneous equations with two unknowns, recording, evaluating and plotting e.g. manual, computerised.	□ This could be assessed through an assignment with learners being given two different linear equations based on a meaningful task.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2		2.1	solve a practical engineering problem involving an arithmetical progression	□ *Arithmetic progression (AP)*: first term (a), common difference (d), nth term = a + $(n - 1)d$; arithmetic series e.g. sum to n terms $S_n = n/2\{2a+(n-1)d\}$.	□ AC2.1 and AC2.2 could be combined into one assignment, relevant to an engineering problem (for example the drilling of bore holes for an arithmetic progression solution and the calculation of drill speeds for a geometric progression solution).
		2.2	solve a practical engineering problem involving an geometric progression	□ *Geometric progression (GP):* first term (a), common ratio (r), nth term = ar^{n-1}; geometric series sum to n terms, $S_n = \frac{a(r^n-1)}{r-1}$, sum to infinity, $S_\infty = \frac{a}{1-r}$ solution of practical problems e.g. compound interest, range of speeds on a drilling machine.	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		2.3	perform the two basic operations of multiplication and division to a complex number in both rectangular and polar form, to demonstrate the different techniques	Addition, subtraction, multiplication of a complex number in Cartesian form, vector representation of complex numbers, modulus and argument, polar representation of complex numbers, multiplication and division of complex numbers in polar form, polar to Cartesian form and vice versa, use of calculator; application of complex numbers in practical situations, e.g. alternating current theory and mechanical vector analysis.	□ Learners could be given different values to demonstrate the two basic operations of multiplication and division to a complex number in both rectangular and polar form, to demonstrate the different techniques.
		2.4	calculate the mean, standard deviation and variance for a set of ungrouped data	□ *Statistical techniques*: review of measure of central tendency, mean, standard deviation for ungrouped data (equal intervals only), variance.	□ AC2.4 and AC2.5 could also be linked and assessed through an assignment or short formal test with a relevant application (for example values of resistors, quality control of a product, overtime working).
		2.5	calculate the mean, standard deviation and variance for a set of grouped data	□ *Statistical techniques*: review of measure of central tendency, mean, standard deviation for grouped data (equal intervals only), variance.	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to manipulate trigonometric expressions and apply trigonometric techniques	3.1	sketch the graph of a sinusoidal trigonometrical function and use it to describe amplitude, periodic time and frequency	□ *Trigonometrical graphs*: amplitude, period and frequency, graph sketching, e.g. sinθ, 2sinθ, ½sinθ, sin2θ, sin½θ for values of θ between 0^0 and 360°; phase angle, phase difference; combination of two waves of the same frequency.	□ AC3.1 and AC3.2 could be assessed by a short formal class test. Alternatively, an assignment could be used with different values for the graphical output given to different learners. Either approach would help ensure answers are authentic.
		3.2	use two of the compound angle formulae and verify their relationship	□ *Trigonometrical formulae and equations*: the compound angle formulae for the addition of sine and cosine functions e.g. sin(A ± B); expansion of Rsin(ωt + п) in the form acosωt + bsinωt and vice versa.	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to apply calculus	4.1	find the differential coefficient for three different functions to demonstrate the use of function of a function and the product and quotient rules	□ *Differentiation*: review of standard derivatives, differentiation of a sum, function of a function, product and quotient rules, numerical values of differential coefficients, second derivatives, turning points (maximum and minimum), e.g. volume of a rectangular box.	□ This could be assessed as a short exercise or assignment, with learners being given a list of the standard differential coefficients and integrals to use. The questions could be written for three different functions to assess all three rules in turn.
		4.2	use integral calculus to solve two simple engineering problems involving the definite and indefinite integral.	□ *Integration*: review of standard integrals, indefinite integrals, definite integrals e.g. area under a curve, mean and RMS values; numerical e.g. trapezoidal, mid-ordinate and Simpson's rule.	□ This could be assessed as a short exercise or assignment, with learners being given a list of the standard differential coefficients and integrals to use. This requires a simple engineering problem (e.g. indefinite integral, given information to find value of constant and hence required equation, definite integral such as area under a curve).

Information for tutors

Delivery

This unit should be delivered at a later stage in the course, after a suitable foundation in mathematics and engineering principles has been established.

Every opportunity should be taken to apply and contextualise the underpinning mathematical principles. Tutors could provide a selection of well-prepared, vocationally relevant examples and assignments that are tailored to area-specific programmes of study, as well as selecting specific applications from the suggested option.

Regular opportunities (for example classroom exercises) to address the relevant techniques should be provided as part of formative assessment. Constant feedback, using additional formative tests and coursework that falls outside the formal summative assessment, could be used to aid learning without necessarily being graded.

The unit content does not need to be taught or assessed in order and it is left to centres to decide on their preferred order of delivery.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Books

Bird J – *Engineering Mathematic* (Elsevier Science & Technology, 2007) ISBN 9780750685559

Tooley M and Dingle L – *BTEC National Engineering: Core units for all BTEC National Engineering pathways*, 2nd Edition (Newnes, 2007) ISBN 9780750685214

Unit 11: Communication through Art and Design

Unit reference number:	**D/502/4969**
QCF level:	**3**
Credit value:	**10**
Guided learning hours:	**60**

Unit aim

This unit aims to develop the breadth and depth of learners' knowledge and understanding of skills in communication through art and design. Learners will achieve this by studying how practitioners use primarily visual imagery to communicate ideas, messages and meaning, and then apply findings to their own ideas.

Unit introduction

The ability to communicate ideas in original and innovative ways is essential for all art, craft and design practitioners. Potential audiences and clients are becoming increasingly knowledgeable about the different forms of communication and there is a constant requirement for fresh, creative ideas to replace or revise familiar forms. In every vocational field of art craft and design, practitioners need to continuously review and update their knowledge, and understanding of and skills in using new and more effective methods of communicating ideas.

Learners will then apply this research to their own ideas, investigating and exploring the communication techniques they have studied.

The unit will enable learners to develop their understanding of how to communicate different meanings and messages, through the manipulation of formal elements in 2D, 3D or time-based media as a means of creating a range of imagery or artefacts for different purposes. The form that works of art and design take, and the media and techniques used to communicate meaning, will vary according to learners' specialisms but it is expected that they will gain experience across disciplines.

Learners must appreciate the need to create informed and stimulating presentations of their intended to communicate ideas to different audiences. Learners will apply visual and non-visual skills in exploring a range of presentation techniques and methods.

This unit could be integrated with specialist unit assignments, as the knowledge, skills and understanding required underpin all other units in the qualification.

Essential resources

Essential resources include:

- specialist workspaces: e.g. studios, workshops, computer suites, video and film editing suites
- materials, equipment and tools: e.g. for 2D, 3D, time-based and associated materials, equipment and tools across all specialist areas
- access to a learning centre: e.g. for books, periodicals, journals, videos, DVD, the internet.

There must be sufficient access to audio-visual and digital resources to enable learners to be aware of the range of possible presentation methods appropriate to their ideas and audiences.

Learning outcomes, assessment criteria, unit amplification and assessment guidance

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Understand how media, materials and processes are used in others' work to convey ideas and meaning	1.1	explain how media and materials are used in the work of others to convey ideas and meaning	□ *Media*: e.g. photographic, painted, drawn, etched, interactive, graphical, fashion, woven, constructed, cast, time-based. □ *Materials:* e.g. paint, plaster, graphite, paper, wood, stone, digital, fibres, metal. □ *Techniques*: e.g. washes, scumbling, solarisation, focusing, composition, layering, cloning, sampling, carving, blocking out, cross-hatching, cutting, fastening, juxtaposing, contrasting, finishing, presenting. □ *Convey ideas and meaning*: e.g. a sense of mystery, atmosphere, style, attract, provoke, sustain interest, sell, create mood, harmony, unintended messages. □ *Others' work*: historical; contemporary; traditional; non-traditional.	□ For 1.1, learners could undertake basic research, appropriate to the intentions of a given brief that requires them to investigate how media, materials and processes are used in others' work to convey ideas and meaning.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Be able to develop visual language	2.1	create own visual language by working with materials, media and processes	□ *Visual language*: formal elements e.g. line, tone, texture, scale, colour, shape, form; expression; feeling; imagery e.g. symbols, impressions, compositions, pictures, visions, semiotics; visual ideas; illustrations; 2D visuals; 3D pieces; time-based pieces. □ *Methods, materials and media*: e.g. 2D media (mark-making, drawing, painting, photography, collage, printmaking, digital media), 3D media (object-making, use of materials, tools, equipment, processes and techniques, carving, modelling, constructing, fabricating, cutting, forming), time-based media (film, video, multi-media, interactive media), combined media (clothing, fashion, animation, performance).	□ For 2.1, learners could work with materials, media and processes primarily linked to their subject specialism in developing their own visual language, following the direction of a given brief.
3	Know how art and design is used to communicate ideas and meaning	3.1	describe ways in which visual language is used to communicate ideas and meaning	□ *Art and design:* specialism e.g. painting, photography, typography, product design, sculpture, video, animation, pattern making, felt making, embroidering, model making, printmaking, dyeing, illustration, game designing. □ *Communicate:* appearance; presence e.g. formal elements, tactile, sound, movement, smell, spatial, interactive; context e.g. presentation, juxtaposition, framing, support, space, surroundings; forms e.g. signs, symbols, billboards, leaflets, paintings, sculptures, on screen, packaging, large scale, small scale, DVD.	□ For 3.1, learners could make direct comparisons showing how visual language is used to convey ideas and meaning in different ways. Descriptions and comparisons should be direct and obvious.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to communicate by using the language of art and design	4.1	communicate an intended meaning to a specified audience using the language of art and design	□ *Communicate an intended meaning*: message; information; expression; idea; feeling; intention e.g. set brief, self-identified brief. □ *Present*: e.g. display, exhibit, project, show, commentary. □ *Specified audience*: e.g. consumers, gallery visitors, fine art 'audience', readers, age range, class, cultural 'sectors', individuals, groups, special interests, needs or requirements, opinion formers, experts, public, private, commercial.	□ For 4.1, learners could demonstrate use of visual language to communicate an intended meaning appropriately to a specified audience. The use of materials, media and processes should be appropriate to the intended outcome.

Information for tutors

Delivery

This unit forms the basis for learners to develop their understanding of communication through art and design and underpins the whole qualification. It could be planned and integrated with other unit assignments. The focus for delivery is through practical approaches to primarily visual studies.

It is essential that learners adhere to health and safety regulations when using media, materials and processes across the specialist areas. Learners will need to undertake a range of activities to communicate meaning or information through the language of art and design. From their explorations, learners will develop focused work for communicating different ideas. Delivery for this unit will include initial activities that explore media, materials and technologies designed to develop specific skills relevant to learners' specialist pathways. The form that work takes will vary according to the specialism but may include 2D, 3D or time-based media. Activities should be planned which develop learners' art and design language skills through observation from primary sources, with a particular focus on mark-making techniques and experience of 3D and time-based materials. The interaction of the visual with other senses, particularly touch related to 3D design, textiles and clothing, and how sound relates to time-based media. These activities can be undertaken discretely, but briefs can provide opportunities for learners to integrate work across the learning outcomes, where possible. Briefs should be structured clearly with specific requirements for the ideas, meaning and messages or information intended for specified audiences where necessary. They should also be negotiated to allow for learner development on an individual basis. Opportunities could be planned to develop learners' skills in communicating ideas to the public, including both commercial and private sectors.

The use of combinations of media and non-traditional materials should be encouraged to broaden learner experience, extend visual thinking and develop their creative and imaginative faculties. Integral to the development of visual skills, will be an ongoing evaluation of learners' use of visual language. Learners will need to recognise strengths and weaknesses in the quality of their visual work, learn to compare the results of their experiments and assess the appropriateness of images in conveying their intended message or meaning. This can be through presentations and group critiques.

Visits to galleries, exhibitions, film reviews, plays, performance and live art, workshops, studios and advertising agencies could play an important role in designing assignments for this unit. Alternatively, bringing professional practitioners from art, design or media backgrounds in to talk about their work could help learners with the evidence needed for this unit.

For learning outcome 1, learners will need to explore how others use visual language. This can be through tutors introducing a wide variety of examples and exposing learners to art galleries, museums, exhibitions, advertisements in print and on websites. Learners will need to consider how formal elements have been used to create effective visual language which evokes different audience responses.

For learning outcome 2, from the above research, learners will extend their use of media, materials and processes to generate and develop their own creative ideas.

This will broaden their visual communication skills and provide the opportunity to focus on conveying appropriate messages for specific audiences.

For learning outcome 3, learners will need to investigate ways in which art and design is used to communicate ideas and meanings. Exploring the work of artists, craft people and designers will form the basis of their research. This could include the visual communication methods of different cultures, contemporary culture and from wider historical sources. By making comparisons and identifying similarities and differences across practices, times and cultures, learners will gain an understanding of the diversity of communication forms in art and design. Ideally, learners should see examples of communication from all specialist pathways, but whatever is selected should be contextualised with in learners' ongoing practical studies. Planned opportunities for viewing and discussing the work of others could be through a series of slide shows, DVDs, film and video, visits to galleries, artists' studios, and environmental exploration such as urban signs and symbols, billboards, advertising, leaflets and packaging. The purpose of learner research will be to evaluate how effectively an idea, a meaning, a message or a piece of information has been communicated to an audience and to enable them apply their knowledge and understanding to inform and inspire their developing studies. Learners might create interim presentations of how their studies have been influenced by others' work, to tutors, peers or others in order to explore the effectiveness of their communication skills.

For learning outcome 4, learners will need to communicate an intended meaning to a specified audience using visual language. From the previous learning outcomes, more in-depth vocational briefs should emerge which could be given to, or negotiated with, learners to provide opportunities for extensive visual investigation. Learners should be encouraged to work with media, materials and techniques across a range of disciplines to communicate analytical, investigative or intuitive qualities based on expression and feeling.

The use of combinations of media and non-traditional materials should be encouraged to broaden learner experience, extend thinking and develop their creative and imaginative faculties. Integral to the development of communication skills, will be an ongoing evaluation of learners' use of the language of art and design. Planned critical reviews, following practical activity, could be of learner presentations, group discussions or individual tutorials. Learners will need to recognise strengths and weaknesses in the quality of their work and learn to make comparisons between results of their experiments and assess the appropriateness of work in conveying their intended message or meaning.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Arnheim R – *Art and Visual Perception: A Psychology of the Creative Eye* (University of California Press, 2004) ISBN 9780520243835

Baldwin J and Roberts L – *Visual Communication from Theory to Practice* (AVA Publishers, 2006) ISBN 9782940373093

Berger J – *Ways of Seeing* (Penguin Classics, 2008) ISBN 9780141035796

Bergstram B – *Essentials of Visual Communication* (Laurence King, 2008) ISBN 9781856695770

Dormor R, Holmes S, Mott T, Schofied J, Thomas L, Wicks S, Wilson G – *Edexcel Level 3 BTEC National Art and Design Student Book* (Edexcel, 2010) ISBN 9781846906374

Dormor R, Holmes S, Mott T, Schofied J, Thomas L, Wicks S, Wilson G – *Edexcel Level 3 BTEC National Art and Design Teaching Resource Pack* (Edexcel, 2010) ISBN 978-1846906374

Frascara J – *Communication Design: Principles; Methods and Practice* (Allworth Press, 2005) ISBN 9781581153651

McNally J – *The Moment it Clicks: Photography Secrets from one of the World's Top Shooters* (New Riders, 2008) ISBN 9780321544087

Park J – *Visual Communication in Digital Design* (YoungJin, 2008) ISBN 9788931434347

Pipes A – *Foundations of Art and Design* (Laurence King, 2008) ISBN 9781856695787

Pipes A – *Production for Designers* (Laurence King, 2009) ISBN 9781856696012

Journal

Visual Communication

Website

www.designmuseum.org Design Museum, dedicated to contemporary design

Unit 12: Visual Recording in Art and Design

Unit reference number: J/502/4965

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit aims to extend learners' ability to select and visually record from a range of sources. Learners will use this information to communicate to different audiences, using appropriate presentation methods and for a range of specific purposes.

Unit introduction

This unit is about developing learners' visual recording skills as an exploratory tool in communicating different ideas. Learning to observe and select visual information from the world around them forms a vital part of this unit. Learners will use primary sources to work from direct observation, developing their skill and understanding, to communicate and express creative ideas.

Our lives today are rich in creative visual imagery. Advertising, film, video and the internet have become an integral part of our visual experience. The quality of our visual world depends to a great extent on the visual recording skills of the artist or designer, and their ability to create exciting, innovative imagery. Recording skills lie at the heart of an artist's success in communicating their message. In the process of generating their ideas, artists, craftspeople and designers need to select, use and refine their recordings in order to communicate with their audience effectively.

The visual recording skills that learners develop through this unit will form the basis for all subsequent units and, therefore, underpin the whole qualification.

In this unit, learners will build their visual language skills and understanding through using the formal elements (line, tone, colour, shape, pattern, surface, structure etc) in a wide range of visual studies activities. Learners

will develop the ability to identify and select for different purposes appropriate visual qualities from direct observation. Understanding the process of exploring and recording will involve experimenting with mark-making using varied materials, techniques and processes appropriate to learners' specialist pathways.

Essential resources

Essential resources include:

- specialist workspaces: for example studios, workshops, computer suites, video and film editing suites
- materials, equipment and tools: for example for 2D, 3D, 4D and associated materials, equipment and tools across all specialist areas
- access to a learning centre: for example for books, periodicals, journals, videos, DVDs, the internet
- specialist staff: for example for the different specialist pathways; this might necessarily include technical support staff.

Visits to galleries, exhibitions, film reviews, plays, performance and live art, workshops, studios and advertising agencies could play an important role when designing assignments for this unit. Alternatively, bringing professional practitioners, from art, design or media backgrounds, in to talk about their work could help learners with the evidence requirements for this unit.

Learning outcomes, assessment criteria, unit amplification and assessment guidance

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Know how to identify sources for visual recording	1.1	identify primary and secondary sources for recording	□ *Identify*: e.g. select sources, visual, non-visual, analysis, observation, natural world, constructed world, macro, micro. □ *Primary sources*: natural world e.g. human form, animals, insects, plant forms, microcosms and structures, land, sea, skies, water, fire; constructed world e.g. built environments, architectural form, urban detail, structure, street furniture, icons, machinery, engineering, products, artefacts, manufactured objects, electronic devices; art, craft and design e.g. paintings, sculptures, clothing, textiles, artefacts, drawings, objects, photographs, screen based, prints. □ *Secondary sources*: e.g. books, journals, internet, video, films, DVDs.	□ For 1.1, learners should demonstrate the ability to identify possible source material, either given by the tutor or selected from their environment, for visual recording. Learner selection of sources should be based on a theme or brief, or a series of focused activities, since they will need to use their recordings to originate and develop ideas towards producing an outcome. There should be evidence of selection from a variety of sources, preferably most from primary experience.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Be able to record visually	2.1	record visually	□ *Record*: e.g. information, ideas, feelings, exploration, alternative approaches; informal e.g. intuitive, experimental, exploratory, feelings; formal e.g. analytical, investigative, methods, materials, equipment, technology, processes. □ *Visually*: e.g. formal elements, visual qualities, materials, surfaces; 2D e.g. painting, drawing, montage, photography, printmaking, digital media; 3D e.g. carving, cutting, shaping, forming, joining, CAD/CAM; moving image e.g. video, audio, animation, performance, music, storyboard, film; sequential and time lapse photography, animation, drawing and painting onto film.	□ For 2.1, learners could select and record visually from appropriate sources, for specific purposes. □ Increasingly complex activities could be set involving experimentation with recording from observation. Learners could use a variety of traditional and digital media and processes, covering different approaches to visual recording. □ Learners could evidence their skills in manipulating the formal elements through visual observation studies using exploratory approaches to media and techniques, broadly as well as those associated with their specialist area. Through different visual recording experiences, learners will evidence progress developing visual recording skills. They should demonstrate understanding of how visual language could be used appropriately to communicate specific information.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Understand visual recording in others' work	3.1	discuss visual recording in others' work	□ *Compare*: e.g. critical analysis, personal judgement; evaluation; contrasting styles and approaches, materials and techniques; scale; purpose, meaning; context; intention; communication. □ *Information*: e.g. factual, instructive, feeling, mood, message, ideas, issue. □ *Spatial information*: e.g. perspective, plans, projections, forms, factual, expressive. □ *Storytelling*: e.g. storyboards, documentary, ideas, visual narrative, illustration, film, animation. □ *Specific information*: e.g. numerical figures, signage, projections, orthographic or isometric information, plans, layouts, patterns, designs, diagrams, instructions. □ *Different audiences*: e.g. specialist pathways, advertising, age groups, design ideas, promotional material, exhibition, screen-based, print-based. □ *Visual recording*: e.g. formal elements, visual language; primary and secondary sources; materials and techniques.	□ For 3.1, learners could research others' use of visual recording for specific purposes. This will include research notes, image collections, and evidence of visits to galleries or records from visiting artists.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Understand own visual recording	4.1	review own visual recording	□ *Review*: e.g. interim, final; formal e.g. tutorials, planned presentations, final project review; informal e.g. crit sessions, discussions, peer and self-assessment; personal judgements; critical analysis; qualities; meaning; purpose/intention; communication; context; annotation, notes, statements, final review. □ *Visual recording*: formal elements e.g. line, tone, colour, shape and form, pattern and surface; observed studies, primary sources, secondary sources, media, materials, techniques and technology; visual language, e.g. composition, structure, balance, contrasts, weight.	□ For 4.1, learners should be able to recognise the relevance of their selected images, and comment appropriately, showing their understanding of the context of selected works. They should also evidence their understanding of the connection between artists' work and their own, and how specific work has influenced their own developments. Learners should provide self-review of their progress. This could be through observed witness statements, presentations, discussions, annotated sketchbooks or worksheets. □ They could consider the needs of different audiences through presenting a range of visual studies, which might include plans, projections, patterns, layout drawings, video clips, spatial information, and other evidence relevant to their chosen area of study.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
5	Be able to develop visual recording to produce outcomes	5.1	develop visual recording to produce effective outcomes	□ *Develop*: e.g. analyse, refine, explore, potential, composition (viewpoint, cropping, enlarging, lighting, movement, structure, balance, arrangement), modify (edit, adjust, clarify, augment, enhance, emphasise, rearrange), feedback. □ *Produce outcomes*: e.g. specialist pathway, series, customised, edition, prints, prototype, plans, designs, maquettes, models, test pieces, final pieces.	□ For 5.1, learners need to understand how visual recording can be used to communicate ideas, such as through making a series of video clips of figures and crowds, streets and interiors to explore and develop ideas for a photography brief about their city's nightlife. They should also be able to analyse and refine their visual studies, showing how this process can be used as a tool for gathering, selecting and presenting visual information for different purposes. For example, learners studying graphic design could show how drawing can support or augment text, as in a book, technical illustration, storyboarding or instruction manual.

Information for tutors

Delivery

Successful delivery of this unit requires creative planning and visual recording experiences that aim to develop learner ability to manipulate the formal elements of line, shape, form, colour, surface and pattern.

Contextualising this unit will give learners opportunities to develop in-depth visual language skills relevant to their own specialism.

Through their visual recording experiences, learners will build the visual language skills of composition, structure and design.

For all subject areas, learners will need to:

- identify and select visual qualities for recording from primary sources
- produce visual studies exploring different media, materials and techniques
- research into the work of others to inform their own developments
- comment on their own and others use of visual language, evaluating their ongoing progress
- develop and produce final work.

Learners need to identify and select appropriate sources for visual recording and analysis. Learning to see and understand what and how to select the most important elements from their chosen subject matter are key to learners' success in developing ideas for their assignments across the different specialist pathways.

Visual recording takes many different forms and will include learners using traditional materials and digital media as means of exploring, recording and understanding visual qualities.

Primary sources give learners first-hand experience in recording the world around them and should be the focus of visual study. No two ways of seeing are alike and through learning to select and record from primary source imagery, learners will develop their own unique vision and build a strong personal identity when developing their ideas. The natural and constructed worlds provide a range of subjects that might be used to stimulate ideas for different activities.

Visual recording from sources requires learners to communicate visual information for different purposes. This may be factual, instructive, to convey qualities of feelings and moods, communicate information or be a documentary. Learners will need to understand the visual characteristics that are most valuable in communicating their ideas successfully. To develop their knowledge and understanding of mark-making, appropriate to their subject, learners will need to practise their skills in recording information, ideas and feelings. They will need to appreciate the difference between informal and formal methods and approaches and tutors will need to set up suitable activities or assignments. Intuitive, experimental approaches might include activities such as exploring lighting to communicate specific moods, where understanding how to record the formal element of tonal qualities will be essential. Analytical, investigative approaches might include activities such as dissecting an object to visually describe its construction, where the formal element of line will be dominant.

Understanding the qualities and characteristics of media, techniques and technologies will form the basis of learners' success in manipulating the formal elements appropriately. Learners will need to have the opportunity to work with a range of processes and techniques using a variety of equipment, materials, technologies and methods. There will be opportunities for a variety of visual studies both in the studio, workshop and outside. Experimentation with media and scale should be encouraged. Learners should be challenged to explore and take risks, push ideas beyond preconceived notions and develop their understanding of recording beyond a narrow and superficial definition. Learners' recording experiences will involve experimental investigation in to the use of different media. They will explore the mark-making potential of specific recording equipment and techniques (for example wet, dry, malleable or non-malleable), analysing the results of their exploration into different media and technologies (for example manual, mechanical, electronic or digital).

Tutors will need to set up opportunities for learners to appraise their ongoing work. Carefully constructed evaluation sessions (that might be formal at a tutorial, or informal in seminar groups discussing and evaluating their progress) should help learners to develop their critical language, as well as giving them a clear sense of how they might improve their own performance. Learners will also gain confidence and develop communication skills through presenting their work to their peers and others, learning to adapt their presentations to suit the needs of the audience. In preparing for their presentations, learners will research how specialist professionals present their design ideas to clients in response to commissions.

It is essential that learners recognise the importance of developing their visual recording skills in a vocational context. Exploring the work of others will give learners a range of exemplar visual studies. Learners need to explore how artists, craftspeople and designers communicate ideas through different approaches to visual recording for specific purposes. This might be achieved through visiting artists or visits to galleries, design studios and workshops. Tutors may also set up demonstrations and provide visual examples of the concepts involved in acquiring accurate and informed visual observation, and in how to select and use media and processes appropriately. Learners might record from objects collected from the locality or from organised visits and field trips with a specific theme, brief or direction. This sense of purpose or intention will enable learners to focus on selecting the appropriate aspects or elements of objects and imagery for recording and communicating purposes.

This unit could initially form part of an induction where learners are taught the necessary visual recording skills and concepts in order to move on to more complex tasks. Planning the coverage of this unit could form part of a wider, integrated delivery of units. This could be through assignment briefs that are specific to one or more chosen specialist pathway units. Tutors should recognise that the unit aims to develop visual recording skills, knowledge and understanding and, as such, underpins all other units in the qualification. This is essential in preparing of a successful portfolio for progression on to employment or higher education.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Cole R – *Perspective for Artists* (Eyewitness DK, 2003) ISBN 9780789468185

Cooper D – *Drawing and Perceiving – Real-World Drawing for Students of Architecture* (John Wiley & Sons Inc, 2007) ISBN 9780470047163

Dormor R, Holmes S, Mott T, Schofied J, Thomas L, Wicks S, Wilson G – *Edexcel Level 3 BTEC National Art and Design Student Book* (Edexcel, 2010) ISBN 9781846906374

Dormor R, Holmes S, Mott T, Schofied J, Thomas L, Wicks S, Wilson G – *Edexcel Level 3 BTEC National Art and Design Teaching Resource Pack* (Edexcel, 2010) ISBN 978-1846906374

Fernandez A and Roig G M – *Drawing for Fashion Designers* (Batsford Ltd, 2008) ISBN 9780713490756

Grey M – *From Image to Stitch* (Batsford Ltd, 2008) ISBN 9781906388027

Hart C – *Drawing Cutting Edge Anatomy – Reference Ultimate Reference Guide for Comic Book Artists* (Watson-Guptill Publications Inc US, 2004) ISBN 9780823023981

Hazel H – *The Encyclopedia of Drawing Techniques* (Search Press, 2004) ISBN 9781844480197

Heller S and Ilic M – *Handwritten – Expressive Lettering in the Digital Age* (Thames & Hudson Ltd, 2006) ISBN 9780500285954

Hughes A – *Interior Design Drawing* (The Crowood Press, 2008) ISBN 9781847970169

Metzger R – *Gustav Klimt – Drawings and Watercolours* (Thames & Hudson, 2005) ISBN 9780500238264

Powers A – *CINEMA 4D: The Artist's Project Source Book* (R & D, 2007) ISBN 9780240809533

Raynes J – *The Complete Guide to Perspective* (F & W Publications, 2008) ISBN 9781906388164

Scarfe G – *Drawing Blood* (Little, Brown, 2005) ISBN 9780316729529

Treib M – *Drawing/Thinking* (Routledge, 2008) ISBN 9780415775618

Vall R van de – *At the Edges of Vision* (Ashgate, 2008) ISBN 9780754640738

Journals

Art Monthly

Art Review

Artists and Illustrators

British Journal of Photography

Contemporary

Crafts Magazine

Creative Review

Dazed and Confused Magazine

Design

Interior Design

Websites

www.artjournal.co.uk	Guide to books and journals
www.craftscouncil.org.uk	National development agency for contemporary crafts in the UK
www.creativehandbook.co.uk	Directory of creative practitioners
www.culture24.org.uk/am30786	Links to a broad range of art and design resources
www.design-council.org.uk	The national strategic body for design
www.designmuseum.org	Design Museum

www.fashion-era.com/C20th_costume_history

Links to resources on fashion

www.graphicdesign.about.com/arts/graphicdesign

Graphic design links

www.hayward.org.uk	Hayward gallery
www.hillmancurtis.com	Film and web-based company
www.masters-of-photography.com	Photography links
www.nationalgallery.org.uk	National Gallery
www.onedotzero.com digital arts	Organisation promoting moving image
www.tate.org.uk	Tate galleries
www.vam.ac.uk	Victoria and Albert Museum

Unit 13: Engineering Design

Unit reference number: Y/600/0258

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit gives learners the opportunity to explore the design process and how it is applied within an engineering context.

Unit introduction

An understanding of how the design process operates within an engineering business is important for anyone considering a career in the design and manufacture of products. This unit provides learners with the opportunity to consider design in a holistic way. It combines study of the technical aspects of engineering design with wider issues such as the environment, sustainability and legislation.

The unit introduces and develops the concept of design for manufacture. It is crucial that the design process be effective. Success in the marketplace can be achieved only if products are fit for purpose, marketable and meet customer requirements. The importance of market research, generation of new ideas and the consequences of poor design are investigated.

Learners will also investigate the issues which influence whether a design proposal should be developed into a final solution suitable for manufacture. These issues include the impact of legislation and standards, the need to conform to environmental and sustainability requirements, materials selection and the types of manufacturing process available. On completion of the unit learners will understand the wider implications of engineering design and the reasons why it cannot be carried out in isolation from the rest of the manufacturing/production process.

The unit content is linked together through a practical task which starts with learners interpreting the requirements of a customer and producing a Product Design Specification (PDS). This is followed by an investigation into the legislation, standards and reference sources that are used by designers who work in manufacturing engineering. This knowledge is then used to influence the production of their own design proposals. These proposals are refined and developed into a final design solution which meets the requirements of the customer. Design ideas will have been communicated using a number of techniques including sketching and formal engineering drawing, design calculations and written commentary.

Essential resources

To meet the needs of this unit it is essential that learners have, or have access to, some if not all of the following:

- a range of customer design requirements
- a range of products to investigate design requirement features
- manual drawing equipment
- 2D commercial CAD software
- extracts and illustrations from appropriate drawing standards and conventions
- access to reference material which provides information about the physical and mechanical properties of materials
- access to legislation and design standards
- component and material suppliers' catalogues.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Know how the design process operates when dealing with customers	1.1	describe the operation of the design process in an engineering company	□ *The design process*: triggers e.g. market pull, demand, profitability, technology push, innovation, market research; process of design for manufacture; decision making; use of new technologies e.g. computer aided design (CAD), simulation, rapid prototyping, computer integrated manufacture (CIM); lines of communication.	□ Evidence could be gained by learners visiting the design department of an engineering company, carrying out an interview with an engineering designer and preparing a short report.
		1.2	interpret the requirements of a given customer and produce a product design specification	□ *Customer*: customer/client relationship; types of customer e.g. external, internal; requirements of customer e.g. performance specifications (physical dimensions, mass), compliance to operating standards, reliability and product support, end of life disposal, production quantities (custom built, modification to an existing product, small batch, large volume) *Product design specification (PDS):* analysis of customer requirements; production of an agreed PDS; documentation e.g. physical dimensions, materials, mass, operation and performance.	□ A written task could be given that asks learners to produce a PDS from the requirements of a given customer.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Know the impact that legislation, standards and environmental and manufacturing constraints can have on the design function	2.1	describe the appropriate legislation and standards which apply to the design of two different products	□ *Legislation and standards*: relevant and current legislation, standards and codes of practice e.g. British Standards (BS), electromagnetic compatibility (EMC) directive, European legislation (European Conformity (CE marking)).	□ Learners could be given an assignment involving a research activity. Two different products need to be given to each learner. They could then carry out research to enable them to describe the legislation and standards that apply to each product (AC2.1). Similarly, they could do the same for the environmental, sustainability and manufacturing constraints that influenced the design of one of these products (AC2.2).
		2.2	describe the environmental, sustainability and manufacturing constraints which influence the design of a given product	□ *Environmental and sustainable constraints*: energy efficiency; environmental impact; constraints e.g. Environmental Protection Act, Waste Electronic and Electrical Equipment Directive; end-of-life disposal e.g. refurbishment, recycling, disassembly, material recovery, non recyclable components. □ *Manufacturing constraints*: availability of resources e.g. labour, material, equipment; influence of physical and mechanical properties of a material in relation to manufacturing methods; cost effective manufacture e.g. set up cost (jigs, tools), production quantities; health and safety in the workplace e.g. Health and Safety at Work etc Act 1974, Control of Substances Hazardous to Health (COSHH) Regulations.	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to prepare design proposals that meet the requirements of a product design specification	3.1	produce design proposals which meet the requirements of a given PDS	□ *Requirements of a PDS*: interpretation of technical requirements e.g. operating performance, physical dimensions; interpret economic requirements e.g. production quantities, product life, market place positioning. □ *Prepare design proposals*: ideas generation e.g. research into existing products, freehand sketching, simulation, flow charts; realistic design proposals e.g. fitness for purpose, manufacturability, aesthetics, ergonomics.	□ For assessment of these criteria an assignment could be set where a PDS is given to learners. Learners are then asked to produce a range of design proposals. Three proposals would generally be sufficient although, if the solutions are complex, two would be enough.
		3.2	extract reference information from component manufacturers' catalogues and materials and design databases	□ *Design reference material*: manufacturers' catalogues e.g. screw fixings, bearings, seals, electrical connectors, drive belts, gear drives; materials databases e.g. mechanical properties, physical properties; design databases e.g. structural beam sections, corrosion protection, anthropometric data.	□ It is important that learners use design reference material. It is intended that the assessment evidence for criterion AC3.2 is based on development ideas generated in AC3.1.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to produce and present a final design solution	4.1	use a range of techniques to present a final design solution which meets the requirements of a given PDS and relevant legislation and design standards	□ *Final design solution*: evaluation of proposals and selection of most appropriate for further development e.g. suitability for available manufacturing processes, cost effectiveness, contribution to profits, visual appearance; development of design proposal into a feasible solution suitable for prototype manufacture e.g. specify materials, appropriate manufacturing processes, estimation of manufacturing cost, quality; conformity to relevant legislation and design standards. □ *Presentation techniques*: 2D engineering drawings e.g. general arrangement drawing, assembly drawing, detail drawings, circuit diagrams, flow diagrams, schematic diagrams; drawing conventions and relevant British Standards e.g. BS308, BS8888, BS7307, BS3939, BS2197; documentation e.g. design diary, logbook, product specification; design calculations e.g. sizes of materials to meet strength requirements, electric motor power, electronic circuit performance, battery life.	□ Learners must use a range of techniques to present the final solution.

Information for tutors

Delivery

There are strong links between the four learning outcomes and the delivery strategy should ensure that these links are emphasised. Learners need to gain a coherent view of the design process within engineering and understand that for a business to remain profitable it is crucial that the design process is effective. Learners must be made aware that success in the marketplace can be achieved only if manufactured products are fit for purpose, marketable and meet customer requirements.

Delivery of the unit should start with some case study analysis. This could be done in the form of a group discussion examining example products that learners are familiar with. It is important to contrast successful design icons, like the Dyson Vacuum Cleaner™ and the Apple iPod™, with those that have failed, such as the Sinclair C5. A wider discussion could follow about why some products are hugely successful whereas others are not. It would also be useful to provide an overview of the design process as it applies to automotive engineering, starting with the initial 'concept' and following through to the production model for the mass market. Why is the production model different from the designer's original? Tutors need to get across the idea of compromise in the design process – the trade off between what we would like and what we can actually have when economics, legislation, manufacturability etc are taken into account.

To effectively cover learning outcome 1, learners could benefit from a visit to the design department of an engineering company in order to find out about the systems in place and the links between design and manufacture. If learners are employed it may be useful to base their research on their own company. Delivery should be, as far as possible, activity based, but care must be taken when covering learning outcome 2. There is a huge amount of data available which relates to the impact of legislation, standards and the environment on the design process, so learners will need to be given guidance when searching for information. Tutors need to consider how this data will be presented as evidence because there is a danger that some learners might include large amounts of unedited material. Learning outcomes 3 and 4 could be covered by a learner-centred activity, based around a single assignment which will produce evidence for the related assessment criteria.

There is scope here for learners to be given a PDS that is tailored to their particular interest but it may be more interesting to give them all the same one and to treat the activity as a design competition. The tutor would assume the role of customer with each learner pitching to get their final design solution accepted.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Books

Dieter G and Schmidt L – *Engineering Design* (McGraw-Hill, 2008) ISBN 9780071263412

Simmons C, Maguire D and Phelps N – *Manual of Engineering Drawing*, 4th Edition (Butterworth-Heinemann, 2012) ISBN 9780080966526

Unit 14: Engineering Drawing for Technicians

Unit reference number: T/600/0266

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

This unit will enable learners to produce engineering drawings of different components, assemblies and circuits using a variety of sketching, drawing and computer-aided drafting techniques.

Unit introduction

It is important that when a product has been designed it is manufactured correctly and to specification. To achieve this it is crucial that the people making the product in a workshop are provided with well-presented engineering drawings, produced to international standards and conventions. This avoids errors of interpretation which can lead to the scrapping of expensive parts.

An understanding of how graphical methods can be used to communicate information about engineering products is an important step for anyone thinking of taking up a career in engineering. This unit gives learners an introduction to the principles of technical drawings and their applications using hand drawing and computer-aided drafting (CAD) techniques.

Learners will start by carrying out freehand sketching of simple engineering products using pictorial methods that generate three-dimensional images. A range of standard components, such as fixing devices, will be sketched together with other solid and hollow items. Learners are then introduced to a more formalised drawing technique that conforms to British Standards and will put this into practice through a number of drawing exercises. A consistent presentation style will be used as learners draw single part components and simple engineering assemblies.

These drawings will contain all the information needed to manufacture or assemble the product, including information such as dimensions, manufacturing notes and parts lists. The use of conventions to represent standard items will be investigated, such as screw threads and springs in mechanical type drawings or circuit symbols such as solenoids and resistors in electrical/electronic type drawings.

Having learned the principles of engineering drawing, learners will then move on to using a two-dimensional (2D) CAD system for the production of drawings using basic set-up, drawing and editing commands. The first task is to produce a drawing template which can be saved to file, as this reinforces the concept of

standardisation and consistency of presentation. This is followed by drawing exercises of single-part components, a simple multi-part assembly and circuit diagrams.

Overall, the unit will develop learners' ability to create technical drawings and allow them to compare the use of manual and computer aided methods of producing engineering drawings.

Essential resources

To meet the needs of this unit it is essential that centres have, or have access to, manual drawing equipment and a CAD system which uses a 2D commercial engineering software package. Centres will also need extracts and illustrations from appropriate drawing standards and conventions.

Learning outcomes, assessment criteria, unit amplification and assessment guidance

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to sketch engineering components	1.1	create sketches of engineering components using a range of techniques	□ *Sketches:* regular solids e.g. cube, rectangular block, 900 angle bracket; hollow objects e.g. circular tube, square section tube; standard components e.g. nuts, bolts, screws, pulleys; engineering components e.g. pulley support bracket, machine vice. □ *Sketching techniques:* sketching equipment e.g. paper (plain, squared, isometric), pencil, eraser; pictorial e.g. oblique drawing (cavalier and cabinet), isometric; orthographic e.g. single and linked views; sketching in good proportion; dimensions e.g. overall sizes, detail.	□ Learners could be given an assignment to cover AC1.1 and AC2.1. This could consist of a small portfolio of sketches and written explanations. Items drawn must include regular solids and hollow objects, standard and engineering components. □ Techniques used must involve sketching equipment, pictorial and orthographic representation and sketching in good proportion with the addition of some dimensions (as specified in the unit content).
		1.2	describe the benefits and limitations of using pictorial techniques to represent a given engineering component	□ *Benefits and limitations of using pictorial techniques:* benefits e.g. speed of production, visual impact; limitations e.g. lengths and shapes not true, not produced to a recognised standard, dimensions difficult to read; consequences of interpretation errors e.g. incorrect manufacture, incorrect assembly, cost to scrap.	

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Be able to interpret engineering drawings that comply with drawing standards	2.1	interpret the main features of a given engineering drawing which complies with drawing standards	□ *Interpret:* obtaining information from engineering drawings e.g. component features, dimensions and tolerances, surface finish, manufacturing detail, assembly instructions, parts list, circuit operation. □ *Drawing standards:* British Standards e.g. BS8888, BS3939, BS2917, PP7307; company-standardised layouts e.g. drawing number, title and issue number, projection symbols (first angle, third angle), scale, units, general tolerances, name of person responsible for producing drawing; line types e.g. centre, construction, outline, hidden, leader, dimension; lettering e.g. titles, notes; orthographic projection e.g. first angle, third angle; views e.g. elevation, plan, end, section, auxiliary; representation of common features e.g. screw threads, springs, splines, repeated items; section views e.g. hatching style, webs, nuts, bolts and pins, solid shafts; symbols and abbreviations e.g. A/F, CHAM, Φ, R, PCD, M; circuit symbols e.g. electrical, electronic, hydraulic, pneumatic.	□ A second assignment could cover AC2.1, and will need to be carefully structured and should be based on a drawing of a component or assembly rather than a circuit diagram so that the unit content can be properly covered.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to produce engineering drawings	3.1	produce detail drawings of three given single-piece components	□ *Detail drawings of single-piece engineering components:* projection method; scale; title block; line work; views; sections; dimensions; tolerances; surface finish; notes.	□ A third assignment could cover AC3.1 and AC3.2, with the three single-piece components being used for the assembly drawing. This would then make the assignment more realistic in terms of what happens in industry.
		3.2	produce an assembly drawing of a product containing three parts	□ *Assembly drawings:* line work e.g. centre lines, construction, outline, cutting plane, sectional view, hatching; representation of standard components e.g. nuts, bolts, screws, keys; parts referencing e.g. number referencing, parts list; notes e.g. assembly instructions, installation features, operating instructions.	
		3.3	produce a circuit diagram with at least five different components which uses standard symbols	□ *Circuit diagrams:* circuits e.g. electrical, electronic, hydraulic, pneumatic; components e.g. transformers, rectifiers, solenoids, resistors, capacitors, diodes, valves, pumps, actuators, cylinders, receivers, compressors.	□ A fourth assignment could cover AC3.3, with learners being given a choice of the type of circuit they produce depending on their interest (i.e. from electrical, electronic, hydraulic and pneumatic). The circuit can be drawn by hand but using CAD would be the preferred method if a library of components is available.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to produce engineering drawings using a computer aided drafting (CAD) system	4.1	prepare a template drawing of a standardised A3 sheet using a CAD system and save to file	□ *Prepare a template:* standardised drawing sheet e.g. border, title block, company logo; save to file. □ *CAD systems:* computer systems e.g. personal computer, networks; output devices e.g. printer, plotter; storage e.g. server, hard disc, DVD, pen drive; 2D CAD software packages e.g. AutoCAD, Microstation, Cattia, Pro/Engineer, Pro/Desktop.	□ AC4.1 and AC4.2 could be covered by a fifth assignment. This could ask for increased competence in the application of standards when producing drawings. To help authenticate learner work, additional evidence could be in the form of witness statements, tutor observation records and 'screen dumps' which show the range of commands used during the development of the drawings.
		4.2	produce, store and present 2D CAD drawings of a given single-piece component and an assembly drawing of a product containing three parts	□ *Produce engineering drawings*: set-up commands e.g. extents, grid, snap, layer; drawing commands e.g. coordinate entry, line, arc, circle, snap, polygon, hatch, text, dimension; editing commands e.g. copy, move, erase, rotate, mirror, trim, extend, chamfer, fillet. □ *Store and present engineering drawings:* save work as an electronic file e.g. hard drive, server, pen drive, DVD; produce paper copies e.g. print, plot, scale to fit.	

Information for tutors

Delivery

All four learning outcomes of this unit are strongly linked and the delivery strategy should ensure that these links are emphasised. The method of delivery should be activity based with learners being shown examples of engineering drawings sourced from actual companies.

Learners need to understand that if products are to be manufactured correctly it is crucial that the people cutting metal or assembling components are given accurate and unambiguous information to work from. Whilst it is not intended that learners become expert draftspersons, it is expected that they will gain the necessary skills in manual and computer aided drafting to be able to communicate effectively using graphics. Delivery of this unit will need to develop practical skills in graphical communication and knowledge of drawing standards.

The starting point for delivering this unit is pictorial freehand sketching using pencil and paper. Very simple items such as a cube of wood can be used to get learners thinking about size and proportion and how to fit the drawing onto a piece of paper. It is useful, even at this introductory level, to introduce the idea of standardisation and to encourage learners to put a border and simple title block onto their work. During the course of studying the unit learners will produce a portfolio of sketches and drawings and it is good practice to develop the concept of a corporate presentation, as would happen in industry.

Some learners will have no knowledge of engineering components and delivery needs to be supported with actual examples that they can hold, look at and sketch. This brings in the idea of pictorial sketching in good proportion. There is no need to use colour or shading effects; just produce outline shapes which can be looked at and used as the basis for development into orthographic form. For example, a simple bracket with a single hole could be sketched using isometric projection and a few leading dimensions added. Then, discuss the problem of drawing the hole so that it appears to be circular (time need not be wasted using the geometrical construction method) and lead on to the idea that, if the component is drawn out using a set of linked 2D views, circles can be easily drawn and lengths become true.

Care should be taken when delivering learning outcome 2 because there is a huge amount of information relating to drawing standards and learners will need to be given a structure to work to when being asked to interpret drawings.

Learning outcome 3 is practical and could be achieved by carrying out a number of developmental drawing exercises, starting with a very simple component. Some centres may wish to start learners on CAD at this point and there is nothing in the unit content to prevent this happening. However, care should be taken to ensure that learners do not get sidetracked by the technicalities of the CAD system and lose sight of what they should really be learning (ie the principles of engineering drawing). When deciding on a method of projection to use, either first or third angle can be chosen but there should be an understanding of the principles of both.

In learning outcome 4 learners are required to produce a standard drawing template. This is a straightforward task and some learners may want to do this early on in the unit so that they can print off their own personalised drawing paper. When delivering this part of the unit, thought needs to be given to authentication of learners' work.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed. For example, 3.3 asks for a circuit diagram to be drawn. This may depend on the learner's workplace experience or chosen area of expertise – they could choose an electrical, electronic, hydraulic or pneumatic system provided that the correct components are picked and represented properly.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Byrnes, D – *AutoCAD 2009 for Dummies* (John Wiley and Sons, 2009) ISBN 9783527704835

Cheng R – *Using Pro/Desktop 8* (Delmar Publishing, 2004) ISBN 9781401860240

Conforti F – *Inside Microstation* V8i (Cengage Learning, 2009) ISBN 9780840031570

Simmons C, Maguire D and Phelps N – *Manual of Engineering Drawing*, 4th Edition (Butterworth-Heinemann, 2012) ISBN 9780080966526

Tooley M and Dingle L – *BTEC National Engineering*, 3rd Edition (Butterworth-Heinemann, 2010) ISBN 9780123822024

Unit 15: Computer Aided Drafting in Engineering

Unit reference number:	**A/600/0267**
QCF level:	**3**
Credit value:	**10**
Guided learning hours:	**60**

Unit aim

This unit gives learners the knowledge and skills needed to use computer aided drafting (CAD) techniques in an engineering context.

Unit introduction

Computer aided drafting is fast becoming the primary means of communicating design information in many industry sectors, particularly in engineering and manufacturing. Two-dimensional (2D) CAD drawings and three-dimensional (3D) CAD data can be shared with computer numerical control (CNC) machines using computer aided manufacturing (CAM) software. 3D models can be rendered to produce photo-realistic representations, or can be animated to produce moving views of products and components as they would appear in service. Additionally, models can be used to analyse features such as mass, volume and mechanical properties.

This unit will enable learners to produce a variety of CAD drawings, from single-part 2D components to complex 3D models. Advanced techniques, such as using pre-prepared symbols to construct circuit diagrams and assembly drawings, will provide opportunities for learners to develop their skills. Learners will also investigate the use of CAD in industry, the hardware and software required and the links with other software packages. In doing this learners will appreciate the advantages of CAD over more conventional methods of drawing production.

Finally, learners will generate 3D models, make comparison with 2D CAD drawings and evaluate the impact of this technology on manufacturing companies and their customers.

The unit as a whole provides an opportunity to carry out practical CAD activities using a full range of commands and drawing environments. In addition, learners will gain an understanding of the use and impact of CAD on the manufacturing industry.

Essential resources

Centres will need to have access to a suitably equipped IT facility with access to a printer/plotter. Access to software with 2D and 3D capabilities, such as AutoCAD and Inventor is also required. Whilst general graphics packages would not be suitable, any CAD software capable of generating the evidence required for this unit would be acceptable.

Learning outcomes, assessment criteria, unit amplification and assessment guidance

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Know the advantages of using CAD in comparison with other methods	1.1	describe the advantages, compared to other methods, of producing drawings electronically using a CAD package	□ *Advantages of CAD*: quality; accuracy; time; cost; electronic transfer of information; links with other software e.g. CAD/CAM, rendering software, animation software, finite element analysis (FEA). □ *Other methods*: manual drafting; model making.	□ Assessment evidence for AC1.1 and AC2.1 could be produced through a case study or through studying the company in which learners are employed, typically taking the form of a written report or presentation. For AC1.1, learners must demonstrate knowledge of how CAD is used in comparison with more traditional drawing methods, stating its advantages and describing how CAD systems can be linked with other software.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Know about the software and hardware required to produce CAD drawings	2.1	describe the software and hardware required to produce CAD drawings	□ *Software*: operating systems; CAD software packages e.g. AutoCAD, AutoCAD/Inventor, Microstation, Catia, Pro/ENGINEER, Solidworks; minimum system requirements e.g. hard disk space, memory required, processor, video card. □ *Hardware*: keyboard; mouse; other input devices e.g. light pen, digitiser, joystick, thumbwheel; monitor; printer; other output devices e.g. plotter, rapid prototyping; storage e.g. floppy disk, hard disk, memory stick, DVD, network.	□ For AC2.1, learners need to describe basic hardware and software requirements to operate a CAD system.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to produce and interpret CAD drawings	3.1	produce 2D CAD detail drawings of five components that make up an assembly or sub-assembly to given standards, using appropriate commands	□ *CAD drawings*: orthographic projections; circuit diagrams e.g. hydraulic, pneumatic, electronic; exploded/ assembly drawing; standards, e.g. BS8888, BS3939, BS2917. □ *Commands*: absolute/relative/polar coordinates; features e.g. linetypes, grids, snaps, circle, text, hatching, dimensioning, layers/levels, colour; viewing e.g. zoom, pan; inserting other drawings e.g. symbols, blocks; modifying e.g. copy, rotate, move, erase, scale, chamfer, fillet. □ *Interpret*: determine properties of drawn objects e.g. list, distance, area, volume.	□ The remaining assessment criteria could be evidenced through a series of competence based practical activities. Evidence could be in the form of witness statements, tutor observation records or a portfolio. □ The process evidence for ACs 3.1, 3.2, 3.3, 4.1 and 4.2 could be obtained from three assignments. For the first assignment learners produce five separate CAD drawings of the components which make up an assembly or sub-assembly.
		3.2	produce a circuit diagram containing at least five components to appropriate standards, using appropriate commands		

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
		3.3	produce an assembly drawing and exploded view of an assembly or sub-assembly containing at least five parts, using appropriate commands	□ *printing/plotting drawings*: using appropriate scale and paper size in order to produce hard copies of CAD-generated drawings of components and assemblies in 1st/3rd angle orthographic projection □ *editing and modification commands*, e.g. array, copy, move, rotate, erase, stretch, trim, scale, chamfer and fillet, change layers, colours and line types	□ For AC3.1, the full range of commands must be used and the drawings should be dimensioned to an appropriate standard. □ These drawings could then be used to produce an assembly and exploded view drawing for AC3.3. □ The second assignment could cover AC3.2. Learners must produce a circuit diagram that could reflect their occupation or area of interest and should be assembled from symbols previously introduced.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to use CAD software to produce 3D drawings and views	4.1	interpret the properties of an engineering component or circuit from a given CAD drawing	□ Produce 3D drawings including circuit diagrams and symbols and associated hardware used in circuit diagrams, e.g. hydraulic, electronic, electrical, pneumatic; interpreting the properties of an engineering component or circuit from a given CAD drawing.	□ The second assignment could also cover AC4.1 by asking learners to interpret and provide a summary of the information contained in a given drawing or circuit diagram.
		4.2	within a 3D environment construct a 3D CAD drawing as a surface and solid model	□ *3D environment*: 3D views e.g. top, front, side, isometric. □ *3D models*: 3D techniques e.g. addition and subtraction of material, extrude, revolve, sweep, 3D coordinate entry (x, y, z), wire frame drawing, 2D to 3D (thickness, extrusion); surface models; solid models.	□ The third assignment could cover AC4.2. Learners need to produce a single 3D model using both surface and solid modelling techniques. This could be a 3D version of one of the part drawings used as evidence for the assembly and exploded view drawing.

Information for tutors

Delivery

This unit is best suited to a practical delivery approach. Since many learners are unlikely to have had prior experience in this area of work, it is essential that some formal introduction to the unit content is given.

Although learners are likely to be relatively proficient in the use of a computer system, the differences (between software they may be familiar with and CAD) should be emphasised. Similarly an introduction to engineering drawing presentation and exercises on how drawings are constructed would be beneficial.

Learners should be given the opportunity to familiarise themselves with the fundamental drawing and editing commands, initially through a series of basic activities that will develop and build on these CAD skills. As learners acquire competence with the range of skills required then the complexity of the drawings tackled could be increased. It is not necessary for this formative work to be presented as assessment evidence. However, these formative activities will enable the tutor to provide practical support and guidance for learners and enable them to gain a view of the learner's progress and potential.

The delivery strategy used should emphasise the strong links between the learning outcomes. Learners need to understand the impact of CAD within business and the advantages and uses of CAD information within industry. A practical approach is required to emphasise the ease and speed of drawing production.

The use of pre-printed activity sheets will allow learners to develop skills and knowledge at an appropriate pace and enable the tutor to focus on those learners who are less familiar with the system. Throughout this process it is important to emphasise the impact CAD has on the communication of information within organisations and on manufacturing, as well as the links with other software packages.

At key points in the learners' development the assignments can be introduced. For example, learners should be able to follow the conventions of constructing CAD drawings using orthographic projection and demonstrate this before the second assignment is introduced.

Similarly, proficiency in the development of circuit diagrams would be expected before undertaking assignment three. Although CAD software can be used to construct circuit diagrams other proprietary software and/or circuit symbols may be used to develop this element as appropriate.

Finally, proficiency in using appropriate 3D tools and techniques would be expected before learners undertake the final assignment.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Ambrosius L – AutoCAD 2009 and AutoCAD LT 2009: All-in-one Desk Reference for Dummies (John Wiley and Sons, 2008) ISBN 9780470243787

Cheng R – Using Pro/Desktop 8 (Delmar Publishing, 2004) ISBN 9781401860240

Conforti F – Inside Microstation V8i (Cengage Learning, 2009) ISBN 9780840031570

Simmons C, Maguire D and Phelps N – Manual of Engineering Drawing, 4th Edition (Butterworth-Heinemann, 2012) ISBN 9780080966526

Yarwood A – Introduction to AutoCAD 2012: 2D and 3D Design (Routledge, 2011) ISBN 9780080969473

Unit 16: 3D Computer Modelling

Unit reference number: A/502/5241

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

The aim of this unit is for learners to develop skills in 3D computer modelling and an understanding of how to develop computer models for different purposes. Through this they will acquire the proficiency to use 3D modelling as an additional design development and presentation tool in their chosen field of design.

Unit introduction

The 3D computer model is a flexible, responsive and multi-functional part of the design process in all areas of 3D design. From jewellery and product design to interior design, architecture and urban design, the ability to analyse and alter a 'virtual' object is invaluable to designers. 3D computer modelling skills will also enable learners to explore career options in areas such as CGI and the film industries, where the use of special effects and animation techniques are well established and continually developing. Interactive media applications and games design also employ 3D computer modelling techniques.

This unit focuses on developing learners' knowledge, skills and understanding of the principles and processes of computer modelling. It offers opportunities for learners to study a range of applications whilst focusing on the use of specific tools and techniques to achieve proficiency in using particular 3D software. Learners will be able to apply skills gained to use 3D computer modelling methods in art and design work. Additionally, they will understand the potential for using these techniques as a presentation tool in their chosen field of art and design. The specifics of the software and hardware available will vary but the areas of study and the skills areas addressed afford a generic treatment (for example model entities, lighting, layers, render modes and material properties). The generic nature of many 3D computer-modelling tools will enable learners to apply their understanding in different software packages in future study.

Learners will develop the necessary skills to manage the virtual environment; create, edit and combine 3D entities and create realistic, accurate and creative models for a variety of specialist areas.

Essential resources

Learners need access to a wide range of resources and facilities depending on the focus of their modelling. Suitable studio and computer facilities with relevant software, peripherals and materials are needed to enable learners to develop, record and present appropriate 2D work and 3D computer models. Library, internet and telephone access are required for research and communication.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to set up, manage and navigate a computer model environment	1.1	set up, manage and navigate a computer model environment	□ *Set up:* e.g. appropriate units and scale, grid size, colour, create and assign layers, coordinate system, origin point, toolbars. □ *Manage*: e.g. set and change work planes, assign model elements to layers, turn layers on and off, set up self-defined camera views. □ *Navigate*: e.g. rotate and reposition model, move camera position, use presets (plan, isometric, front side elevation), self-defined views, zoom in, zoom out, use X, Y and Z axes, relocate work-plane (view, entity, origin surface). □ *Workflows*: e.g. different processes in software (Maya, Lightwave).	□ Learners must set up, manage and navigate a computer model environment. They could demonstrate their knowledge of individual components and their influences on the working environment and any subsequent modelling. Learners could show that they are competent with tools and controls that set up and change the position of the point of view, and are able to manage all of these effectively. Evidence for AC1.1 could be generated through witness statements, examination of settings on saved files and written evidence such as a technical file or written tests.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Be able to create 3D objects and surfaces	2.1	create 3D objects using tools and commands	□ *Create 3D objects*: e.g. box, sphere, cone, cylinder, prism, wedge torus, loft extrude 2D entities, revolve 2D entities.	□ Learners could create 3D objects using appropriate tools and commands. They could demonstrate awareness of the different object properties and be able to work with these to edit entities. □ Learners could show recognition of tool icons and describe their functions.
		2.2	modify and edit 3D solids and surfaces	□ *Modify and edit*: e.g. dimensions, scale orientation, relocate object origin, move nodes (add, remove), Boolean operations (adding, subtracting and intersecting 3D entities), edges (add radii and chamfers).	□ Learners could edit and modify 3D solids and surfaces.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to use lighting and rendering	3.1	use lighting and rendering to enhance computer models	□ *Use lighting*: e.g. appropriate light (ambient, directional, spot, point, sky), light properties (set, edit, colour, intensity, cone), adjust (ambient, specular, diffuse components, control resolution, softness, shadows). □ *Rendering*: e.g. wireframe, suppress hidden lines, draft and quality render, enhance visualisation, editing of 3D models, set modes (Gouraud, Phong, Raytrace, Radiosity) assign preset materials, edit material qualities, (colour, scale, roughness, mirror factor, transparency, grain direction, scale). □ *Texturing*: creating textures (unique, repeating).	□ Learners could use different types of lights, render modes and materials to enhance computer models. They could show evidence they are aware of the effects of lighting and material elements and how to alter integral components within these to achieve specific results.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Understand how to develop computer models	4.1	review computer models	□ *Review*: effectiveness e.g. individual elements of the project, time management, design development, strengths, weaknesses, compare, contrast, own work, others' work, quality and accuracy of model, individual component elements, appropriateness of outcome(s) against brief. □ *Present computer models*: e.g. save models and views, appropriate file formats, compression, display on the internet, multimedia presentation, electronic documents, paper-based visuals, printed media, hand-rendered images sketches, technical drawings, physical models, maquettes.	□ Learners could review their working methods and work in relation to that of others, in the broader context of current professional practice. They could show awareness of the different vehicles and arenas for showing computer models and that they understand and are able to work in the format(s) associated with these. □ Learners could present their own computer models in formats relevant to the brief, taking into consideration file formats, possible end users and methods of communication through online communication, screen displays or paper-based presentations.
		4.2	present own computer models		

Information for tutors

Delivery

For this unit learners need access to the appropriate hardware, professional computer modelling software and peripherals with relevant technical support. They will need to be made aware of the health and safety issues relating to prolonged computer use.

Tutors delivering this unit need to provide specific practical and technical support to enable learners to develop creative work. Tutors need to instruct learners in the use of tools and techniques to enable them to become proficient in these practical skills. A wide range of professional work should be made available and learners should be encouraged to analyse and discuss their work in historical and theoretical contexts. Learners should record technical and reflective information so that they can evaluate their actions and outcomes.

Well-equipped facilities that offer peripheral devices in support of high specification hardware and professional computer modelling software are needed for this unit. Spending long periods of time at a computer station poses problems and learners need to be made aware of all health and safety issues relating to the use of computers and peripherals.

Tutors should ensure that learners have access to sufficient numbers of technical and training manuals for the software with which they are working. Tutors should also carry out a search of user group and technical support websites in order to provide learners with a comprehensive list of relevant sites.

Tutors could enable learners to engage in realistic projects through the presentation of professional or client led briefs. Tutors may be able to source such a project in their locality. Whether a live assignment is used or not, projects should reflect current professional practice and should allow the development of different aesthetic styles. Learners should also be given the opportunity to create accurate computer models of actual objects as well as their own ideas and concepts.

Tutors should use briefs that set out realistic scenarios in order to motivate, inspire and stimulate learners.

For learning outcome 1, learners need to be taught how to set up the working environment for particular software prior to commencing modelling and how to manage and navigate that environment during modelling. It offers the opportunity for learners to become familiar with the coordinate system, layers and other elements, which should be set prior to modelling. Learners should be encouraged to plan and set up their environment to suit the specifics of the proposed model.

For learning outcome 2, learners need to be taught to build simple 3D objects, how to edit, combine and copy these and how to use Boolean operations in order to construct complex 3D entities. Learners also need to be taught in lofting, revolving and deforming techniques and tools. Much of this outcome may involve tutor demonstrations followed by learner activity with appropriate technical support.

For learning outcome 3, learners should be instructed in the use of different types of lights and their specific qualities to effectively enhance model clarity and render quality. They should also learn to assign and edit materials in order to realistically render models. It is important that learners understand the different render modes and when and how to use them to their advantage.

Learning outcomes 2 and 3 are closely related and may be addressed simultaneously or sequentially. They represent the body of skills required to create, develop and realise effective computer models. Tutors may wish to ensure learners have acquired a level of proficiency with learning outcome 2 before introducing the elements required for learning outcome 3. Tutors should balance the periods of instruction, in order to ensure learners acquire the knowledge and understanding, with periods of exploration to enable them to develop free expression, confidence and a degree of autonomy.

Learning outcome 4 requires learners to review their work practically and contextually. Tutors should encourage learners to continuously record and comment on their work and working methods and to discuss the issues surrounding contemporary practice. Learners should also be made aware of the range of applications and formats for presenting computer models, as well as the 2D images generated from them. Tutors should ensure that learners have opportunities to present their work in a number of different formats and arenas.

Assessment

The centre will devise and mark the assessment for this unit. Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Bousquet M and McCarthy M – *3ds Max Animation with Biped* (New Riders, 2006) ISBN 9780321375728

Journals

Computer Graphics World

Websites

www.CGW.com	Computer Graphics World Magazine
www.skillset.org	The Sector Skills Council for Creative Media

Unit 17: Human-scale Design

Unit reference number: T/502/5268

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

The aim of this unit is to enable learners to research creative human-scale design through the work of professional practitioners. They will apply their knowledge of ergonomics and anthropometrics to the design and production of objects for human use in different contexts.

Unit introduction

The process of designing artefacts, products and equipment for human use is a complex and absorbing one, in which the designer is constantly engaged in the process of research, development and testing of ideas. In this unit learners will develop a range of skills and processes, which they will apply to produce outcomes to suit the requirements of realistic briefs.

This unit focuses on the study of human-scale, 3D design, enabling learners to put their ideas into practice within a professional context. Learners will apply their understanding of ergonomics and anthropometrics to the design and production of designed objects for human use. They will gain skills in the practical design and making of models, prototypes and products such as furniture, goods for the domestic commerce and entertainment markets and different kinds of human-scale transport.

Learners will develop the skills to enable them to interpret the aesthetic and functional requirements for human-scale 3D design briefs for a variety of specialist design areas in the domestic and wider world. Learners will be taught how to identify and apply functional criteria to meet the ergonomic and anthropometric requirements of the brief.

Functional criteria will vary according to learners' intentions but could include size, scale, weight, strength, textural qualities, fit, comfort, effectiveness in use, and health and safety. Learners will use their developing understanding of the physical nature of the human figure in producing designs, working drawings, test models, considering skeletal structure, muscles and movement, drawings and visual analysis of the figure, and anthropometrics.

Essential resources

Learners need access to a wide range of resources and facilities dependent on their chosen area of specialisation. There should be suitable studio and workshop spaces and tools and materials that will enable learners to develop appropriate 2D and 3D work. For research, learners need access to a learning resource centre and the internet. Suitable computer access with relevant software would enhance the experience and support the achievement of learning outcomes.

This unit requires the support of a well-equipped 3D workshop facility. Learners need access to a variety of hand-held and power tools as well as a variety of sculptural materials, malleable and non-malleable. Access to design areas and drawing studios for recording from primary sources, ideas origination and development is essential. Both specialist and general learning support materials including books, journals, periodicals, computer access to the internet together with a range of design software are necessary to support learners in their historical, cultural and contemporary contextual research.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to research a brief for human-scale design	1.1	research a brief for human-scale design	□ *Research*: work of others; materials e.g. traditional, non-traditional; techniques; processes. □ *Aesthetic requirements*: e.g. appearance, style, materials, relationship to environment, end user. □ *Constraints*: costs of materials; production; time; material properties; legal, e.g. health and safety, building regulations; production processes. □ *Needs of the clients and others: quantities:* durability; life span of product; environment; suppliers; manufacturers.	□ Learners could analyse and respond to a brief and carry out targeted research in appropriate areas. Work referenced must be appropriate. □ Assessment evidence could come, primarily, from practical work and should include written analysis and evaluation as well as design visuals and models. Some evidence for AC1.1 could be gathered through group discussions or individual interviews.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Know about ergonomic and anthropometrical principles in meeting the functional criteria of design briefs	2.1	identify ergonomic and anthropometrical principles when meeting the functional criteria of design briefs	□ *Ergonomics*: anatomy; physiology; psychology; equipment and systems; working posture; working environment. □ *Anthropometrics*: human dimensions e.g. male and female differences, international variations; reaching zones (horizontal, vertical, seated, standing); field of vision e.g. visually impairment	□ AC2.1 requires learners to demonstrate a clear understanding of the relationship between ergonomic and anthropometric factors and the design outcome of any given brief. □ Assessment evidence could come, primarily, from practical work and could include written analysis and evaluation as well as design visuals and models. Some evidence for AC2.1 could be gathered through group discussions or individual interviews.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to plan, design and make creative models and prototypes for human-scale products	3.1	plan, design and make creative models and prototypes for human-scale products	□ *Plan*: e.g. establish a timetable, organise meeting schedule, allocate time, resources. □ *Design*: record ideas e.g. written notes, sketches, technical drawings, concept models; modify initial ideas e.g. alternative materials, stylistic alterations, physical alterations; feedback e.g. consultation, clients, other users. □ *Make creative models and prototypes*: e.g. experimental, scale models, mock-ups, exploratory 3D concepts; test material properties e.g. sampling, fixings, finishes, functional properties, aesthetic qualities.	□ AC3.1 requires learners to carry out the process of designing and modelling of creative outcomes within a planned timetable. □ Assessment evidence could come from practical work and could include written analysis and evaluation as well as design visuals and models.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Understand working methods, design development and effectiveness of final human-scale design outcomes.	4.1	discuss working methods, design development and effectiveness of final human-scale design outcomes	□ *Working methods*: e.g. design process, technical process, planning, time management, health and safety, coordination with others, collaboration, meeting client needs, creative response, quality assurance. □ *Design development*: e.g. starting point, response to feedback, opportunities, constraints, choice of materials, aesthetic considerations, time management; justifications, decisions, outcomes. □ *Effectiveness*: e.g. against brief, purpose, strengths, weaknesses, success, feedback, user experience, comfort, security, durability, accessibility, environmental impact. □ *Human-scale design outcomes*: context; setting e.g. domestic, social, open space, commercial, industrial, mixed use, architectural, workplace, spatial requirements; materials e.g. textures, surfaces, finish, detailing, colour, sound qualities; artefact e.g. chair, handle, fastening, doorway, table, keyboard, hand-held device.	□ AC4.1 is concerned with the ongoing process and requires learners to systematically consider the progress and qualities of their own and others' work. □ Assessment evidence could come from practical work and could include written analysis and evaluation as well as design visuals and models.

Information for tutors

Delivery

This unit focuses on the study of human-scale, 3D design, enabling learners to put creative ideas into practice within a professional context. Learners will apply their understanding of ergonomics and anthropometrics to the design and production of objects for human use.

This unit has been designed to engage learners in realistic projects through the presentation of professional briefs. Typically, projects could be set to reflect current professional practice. Depending on the choice of specialist area, projects could be set for a wide range of media, materials and processes. Tutors should use realistic scenarios in order to motivate, inspire and stimulate learners.

This unit could be delivered through a programme that is predominantly practical, so that learners gain an understanding of design methods through experience rather than theory. In particular, learners should gain enough exposure to professional practice to recognise the significance of a methodical approach to solving the specific design problems of human-scale design and develop their practical skills in relevant areas.

It is equally important to demonstrate that there is no single method or design process that can be applied to all creative work. There is a difference between the free exploration and origination of ideas, and the means whereby they can be developed to meet specified design requirements.

For learning outcome 1, learners need to be taught how to analyse and clarify a brief in order to establish its specific requirements and restrictions. They need to be taught also how to use selected relevant information and reference materials from specific, targeted research.

For learning outcome 2, learners need to be made aware of the importance of ergonomics and anthropometrics in designing for human use and learn to recognise these influences in their own and others' work.

Learning outcomes 1 and 2 offer the opportunity to link research to the specifics of a brief as determined through analysis. Learners need to be taught the concept of design development in response to a given brief, the discussion of ideas with other parties and the role of ergonomics and anthropometrics in human-scale design.

Tutors should encourage learners to participate in the analysis and questioning of the briefs directives. Learners should be taught where to seek legislation and other documentation relevant to their design area and how to apply these to their own work.

For learning outcome 3, learners need to demonstrate their understanding of the necessity of planning, modelling and prototyping when responding to briefs. Learners should develop their understanding of this cycle and their ability to apply it in a variety of different contexts. Learning outcome 3 has links with learning outcome 4 and learners should be encouraged to test their ideas through prototypes, proofs, maquettes or other appropriate pre-production models and mock-ups. Tutors should encourage learners to participate in the analysis and evaluation of their own and others' work at all stages. Learning outcome 3 is predominantly craft based and learners should be given instruction and opportunities in all relevant 2D and 3D design skills. The link between learning

outcomes 3 and 4 should be used to emphasise the importance of regular analysis and evaluation of ideas and alterations during the development stage. Learners should be taught how to question and test their ideas and to critically assess the success of outcomes.

For learning outcome 4, tutors should encourage learners to explore 3D ideas and to investigate a range of alternative materials in the process of creating final human-scale design outcomes. Learners should creatively experiment with materials and processes and record critical opinions via worksheets or sketchbooks. While engaged in any 3D making activities, learners should be fully aware of all relevant health and safety requirements for the materials and the processes they are using.

Learners need to develop their critical skills through ongoing analysis to review the progress of their own and their peers' work in designing human-scale 3D products to meet briefs. Group and individual presentations should be encouraged where learners will develop their use of the correct technical terms when talking about the materials and techniques they have used and how they meet the aesthetic and functional criteria identified in the brief. Regular feedback should be given to learners through day-to-day discussion and formal and informal interim assessment. Evidence of evaluation for learning outcome 4 can take the form of notes, formal evaluative statements and records of verbal feedback.

Assessment

The centre will devise and mark the assessment for this unit. Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Norman D A – *Emotional Design: Why We Love (or Hate) Everyday Things* (Basic Books, 2005) ISBN 9780465051366

Norman D A – *The Design of Future Things* (Basic Books, 2009) ISBN 9780465002283

Slack L – *What is Product Design?* (RotoVision, 2006) ISBN 9782940361243

Weizhi C – *Big Book of Creative Product Design* (Links International, 2008) ISBN 9788496969254

Journals

a-n Magazine

Blueprint

Contemporary

Crafts Magazine

Creative Review

Design issues

Make

New Ceramics

World of Interiors

Websites

www.burrows.com/found.html	Founders of the Art and Crafts movement
www.coshh-essentials.org.uk	COSHH Essentials
www.designboom.com/eng/education/rockingchair.html	History of rocking chairs
www.designcouncil.org.uk	Design Council
www.designobserver.com/archives/category.html	Catalogue of writings on design and culture
www.ergonomics.org	All about ergonomics
www.eyemagazine.com	*Eye Magazine*
www.vam.ac.uk	V & A museums and collections

Unit 18: Design Methods in Art and Design

Unit reference number: T/502/4976

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

The aim of this unit is to enable learners to develop skills and understanding of the design process and skills in applying this in the creation of art and design work.

Unit introduction

When developing designs to meet the requirements of a brief, the development cycle used is vital in ensuring effective outcomes. The application of a design methodology will ensure that all significant factors are considered in a structured way. Designers need to be able to develop and communicate their ideas and concepts through 2D and 3D skills. It is important for learners to develop the necessary knowledge, skills and understanding to enable them to communicate their intentions effectively.

In this unit, learners will develop an understanding of the importance of using the appropriate methods to achieve their creative intentions. They will develop ideas and focus concepts within the confines of specific briefs. They will learn to communicate their ideas and intentions professionally, through visual and verbal communication and the consultation process.

Briefs should be written and presented in a vocational context, providing opportunities for learners to work on realistic scenarios and outcomes. Projects can be set in both 2D and 3D areas to meet the specific needs of learners.

Learners will develop the necessary research and analysis, synthesis, and time management skills, as well as teamwork and organisational skills. They will be introduced to the design development cycle through specific project briefs.

Learners will need to be aware of legal constraints, such as copyright, building regulations and health and safety issues associated with specific materials, techniques and practices, which impact on their proposals.

The unit gives learners the opportunity to explore all areas of visual communication, including mind mapping, concept sketches, experimental and scale modelling, proofs, mood boards, colour/sample boards and final presentations.

Essential resources

Learners will need access to a wide range of resources and facilities which will depend on their chosen area of specialisation. Suitable studio and workshop space will enable learners to develop 2D and 3D work.

Library, internet and telephone access will allow research and communication. Suitable computer access with, relevant software, would enhance the experience and support the achievement of learning outcomes.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Understand the design development process	1.1	describe the design development process	□ *Analysis and clarification of the brief*: requirements, .e.g. specifics, restrictions, discussion, definition, clarification □ *Planning*: timeline, e.g. design stages, organisation, meeting schedule; allocation, e.g. time, resources, research, development, implementation, revisions, contingency, presentation □ *Consultation*: e.g. clients, end users, interested parties, colleagues □ *Process*: research, e.g. work of others, similar context, comparisons, historical, contemporary, other contexts; working methods, e.g. traditional, non-traditional, materials, techniques, examples of design work; initial ideas, e.g. ideas generation, mind mapping, mood boards, concept sketches, exploratory, working models, alternative solutions □ *Design concepts*: e.g. 2D visuals, proofs, mock-ups, maquettes, samples, test pieces □ *Review and modification*: e.g. discuss, select, reject initial ideas, propose, alter, implement □ *Final outcome*: e.g. artefacts, designs for production, prototypes, presentation of designs in response to brief □ *Evaluation*: effectiveness, e.g. time management, outcome(s) against brief, strengths, weaknesses	□ Learners will be expected to demonstrate their awareness and understanding of the factors that affect the design development process. They will need to analyse and respond to a brief, as well as analyse and evaluate their own design process showing which factors influenced development. Assessment evidence should come from practical work and include written analysis and evaluation as well as design visuals. There will be significant tutorial input.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
2	Be able to use the design development process in own work	2.1	use the design development process in own work	□ *Identify and clarify design opportunities*: consult, e.g. clients, colleagues, end users □ *Develop ideas in response to research and the brief*: record ideas, e.g. written notes, records of collaboration, sketches, concept models; modify initial ideas, e.g. alternative materials, stylistic alterations, physical alterations; produce experimental models, scale models □ *Produce effective design solutions*: innovation; sustainability; alternative options; consultation, e.g. feedback, clients, other users; solutions, e.g. select, preference, requirements of the brief	□ Learners need to produce effective design solutions, to a given brief, as a result of the development cycle. Learners will need to support changes made to their initial ideas. Assessment evidence should come from practical work and include written analysis and evaluation as well as design visuals. There will be significant tutorial support and guidance.
3	Be able to communicate ideas and intentions clearly	3.1	communicate ideas and intentions clearly	□ *Consult with clients and others*: verbally; using appropriate language (professional terms, conventions, written and spoken) □ *Review feedback*: comments; review proposals; revise proposals □ *Communicate intentions*: visually, e.g. creative visuals, models, technical drawings, clear annotations, proofs; diverse methods; develop online communication skills, e.g. video conferencing, webcams, online collaboration, electronic proofing	□ Learners need to communicate ideas and intentions at all stages of the design development cycle. As well as practical work, assessment evidence might be generated through correspondence, witness statements or observation records.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
4	Be able to work safely with others	4.1	work safely with others	□ *Work within health and safety and other legal constraints*: e.g. building regulations, Disability Discrimination Act (DDA), copyright law, Control of Substances Hazardous to Health (COSHH) Regulations 2002; safe operation of tools and equipment; maintaining a safe studio environment	□ Learners need to work safely and constructively with others. Again, assessment evidence could come from witness statements and observation records, as well as from practical work.

Information for tutors

Delivery

This unit offers tutors and learners opportunities to engage with internal and external professional briefing activities, working to current professional practice and using a wide range of media, materials and processes.

Tutors should use realistic and/or actual scenarios to motivate, inspire and stimulate learners. By developing industry links, learners can benefit from opportunities to communicate their innovative ideas and proposals in a professional context.

This unit has been designed so tutors can engage learners in realistic projects through the presentation of professional briefs. Projects should be set to reflect current professional practice. Depending on the choice of specialist area, projects should be set so that learners use a wide range of media, materials and processes.

Tutors should use a wide range of realistic scenarios in order to motivate, inspire and stimulate learners.

This unit should be delivered through a practical programme, so learners gain an understanding of design methods through experience rather than theory. In particular, learners should have enough exposure to professional practice to recognise the significance of using a methodical approach to solving design problems, particularly within a team.

It is equally important to show that there is no one method or design process that can be applied to all creative work. There is a difference between the free exploration and origination of ideas, and how they can be developed to meet specified design requirements.

Health and safety issues relating to work in studios, workshops and relevant specialist areas, should be emphasised and documented throughout. Learners will need to be guided through current legislation such as the Disability Discrimination Act (DDA), building regulations and copyright laws.

Learning outcomes 1 and 2 are closely linked and give learners the chance to learn from experience. They cover the concept of design development in response to a given brief, the recording of initial ideas, the discussion of ideas with other parties, and the alteration and improvement processes used in response to these. Learners will need to participate in analysing and questioning the brief's directives.

Learning outcome 1 covers work sequences, time management, setting and meeting targets within deadlines, adapting to new demands when they arise, and organising resources when planning and developing work.

Learners will also learn how, through research, to select, find and use relevant information and reference materials. Learners will review work in progress and implement modifications to improve their design ideas.

For learning outcome 2, learners will demonstrate their understanding of the design cycle through responding to briefs. The briefs should be structured to enable learners to develop their understanding of the design cycle and their ability to apply it in a variety of different contexts.

Learners should also be encouraged to question their own and others' outcomes at all stages. Learners should test their outcomes through prototypes, proofs, maquettes or other appropriate pre-production models and mock-ups. Part of their development could involve producing a reflective practice model, which could be implemented across all units at all levels.

Learning outcome 3 covers the communication of ideas through appropriate methods. This is fundamental to the design profession and learners should be given opportunities to communicate their ideas in a number of formats. They should be taught to use suitable written and verbal language and to communicate through both 2D and 3D representations, as appropriate. Learners need to learn how to work constructively with others. They need to develop appropriate communication skills in order to use language clearly, creatively, accurately and effectively.

Learning outcome 4 covers professional practices and legal requirements. Learners should be taught where to seek legal documentation relevant to their specialist design area. Learners should also be taught what legislation relates to their chosen specialism and how it restricts work within specific briefs.

Learners will need to be made aware of up-to-date health and safety legislation. They will need to use their understanding to maintain a safe, healthy and secure environment and to act responsibly themselves and with others in their team.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Bowers J – *Introduction to Two–dimensional Design: Understanding Form and Function* (John Wiley & Sons Inc, 1999) ISBN 9780471292241

De Sausmarez M – *Basic Design: The Dynamics of Visual Form*, 2nd edition (Herbert Press Ltd, 2007) ISBN 9780713683660

Dormor R, et al –*BTEC Level 3 National Art and Design Student Book* (Edexcel, 2010) ISBN 9781846906374

Dormor R, et al – *BTEC Level 3 National Art and Design Teaching Resource Pack* (Edexcel, 2010) ISBN 9781846906381

Hickman R (Ed) – *Research in Art & Design Education: Issues and Exemplars* (Intellect, 2008) ISBN 9781841501994

Pipes A – *Drawing for Designers: Drawing skills, Concept sketches, Computer systems, Illustration, Tools and materials, Presentations, Production techniques* (Laurence King, 2007) ISBN 9781856695336

Schön D A – *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning*, New edition (Jossey Bass, 1990) ISBN 9781555422202

Urban Design Associates – T*he Urban Design Handbook: Techniques and Working Methods* (W W Norton & Co, 2003) ISBN 9780393731064

Journals and/or magazines

Design Journal

Design Week

Reflective Practice

Websites

www.designcouncil.org.uk	the national strategic body for design in the UK
www.designmuseum.org	website of the Design Museum, dedicated to contemporary design

Unit 19: Human-scale Working

Unit reference number: K/502/5266

QCF level: 3

Credit value: 10

Guided learning hours: 60

Unit aim

The aim of this unit is to develop learners' understanding of ergonomic factors through the making of human-scale artefacts. They will develop skills applying ergonomics in the design and development of their models and evaluate the quality of their results against a brief.

Unit introduction

In working through this unit, learners will demonstrate their understanding of ergonomic factors through clearly documented human-scale working ideas. They will employ ergonomics in the design and development of their models and evaluate the quality of their results against the brief.

Designers working in 3D disciplines will consider ergonomic factors when designing for specialist areas such as furniture, domestic industrial design, product and different kinds of transport design. Intelligent design can significantly improve the aesthetic and functional aspects of our lives. It can improve the efficiency and comfort of our home environment. Our journeys to and from work are made less stressful when the vehicles or transport interiors and seating are better suited to our body shape. Good design can enhance the objects, furniture and equipment we use in our everyday lives – in the kitchen, the office or workplace and the living room.

The application of ergonomics involves the designer considering the size, shape, structure and movement of the human figure when designing objects for human use. The ability of the designer to recognise these factors and build them into the design process is paramount to the success or otherwise of the item, object or product. It also involves the designer in considering the qualities and characteristics of different materials and their suitability for specific uses.

Learners will work with drawing systems to develop their design ideas, and take these into the production of maquettes and models. They will then review these outcomes against the original intentions for their proposal or brief. In this way, learners will be experiencing aspects of the design process that will provide useful and important insights that they can apply to their specialist study. They will also evaluate the characteristics of materials in terms of texture, strength, aesthetics and so on. These considerations will be supported through learners' investigations of different techniques and processes that they may use in working with materials.

Briefs should be written and presented in a vocational context in order to encourage learners to work on realistic scenarios and outcomes, taking into account any relevant legal requirements such as health and safety issues and regulations in the use of construction media and techniques as appropriate.

Essential resources

Learners will need access to a range of visual and technical resources, including photographic facilities. The workshops should be equipped to a good standard for work with a wide range of materials and include a separate area for wet work and mould making, a heat treatment area with appropriate extraction facilities, a clean area for drawing and preparation, a finishing area, and storage space for work in progress.

Resources for research and project development should include access to design areas and drawing studios. Both specialist and general learning support materials, including books, journals, periodicals, computer access to the internet together with a range of design software are necessary to support learners in their historical, cultural and contemporary contextual research and in their use of 4D design application.

Learning outcomes, assessment criteria and unit amplification

To pass this unit, the learner needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
1	Be able to investigate the properties of materials, techniques and processes for human-scale design	1.1	investigate the properties of materials, techniques and processes for human-scale design	□ *Materials, techniques and processes*: e.g. a range of malleable and non-malleable material, e.g. wood, metal, plastics, card, rubber, fabrics, found or recycled; material and structural properties e.g. strength, durability, malleability; aesthetic qualities, e.g. visual, tactile, surface qualities; working characteristics, e.g. cutting, piercing, removing, redistributing, joining, constructing, assembling, upholstering, testing, finishing; suitability for purpose, e.g. replicate, scale up or down, commercial outcomes, meet design intentions	□ Learners will be able to record and present limited information on materials, techniques and processes. The range of information will be limited, and the enquiry will be at a basic level.
2	Be able to investigate ergonomic factors in human-scale artefacts		investigate ergonomic factors in human-scale artefacts	□ *Ergonomic factors*: e.g. research; visual analysis; skeletal structure, muscles and body movement; functions of parts of the body; human anatomy; measurements, e.g. human figure, projected/actual artefacts; scale, proportion; size, height, weight; comparisons, e.g. figure to artefacts; test pieces, maquettes, models, prototype; 2D, 3D and 4D design; contextual references	□ Learners will show a basic ability to research ergonomic factors. The range of factors explored will be limited. Language used in evaluating and explaining the effects of the factors will be basic.

Learning outcomes		Assessment criteria		Unit amplification	Assessment guidance
3	Be able to develop and communicate ideas using 3D drawing systems		develop and communicate ideas using 3D drawing systems	□ *Develop and communicate ideas*: e.g. design briefs; target client; focus; ideas; source material; contextual references; ergonomic factors; design drawing; digital imaging programmes; presentations, e.g. different audiences □ *3D drawing systems*: e.g. freehand drawings; design ideas; working drawings; presentation worksheets; perspective studies, orthographic techniques, CAD, e.g. software programmes; photographic studies	□ Learners will show a basic ability to develop ideas using 3D drawing systems. The level of skills shown will be basic, and the range of systems explored and used will be limited.
4	Be able to record, evaluate and present outcomes of investigation		record, evaluate and present outcomes of investigation	□ *Record and evaluate*: select; e.g. sources, ideas, media, materials, processes; analyse, e.g. modify, adapt, refine, 3D drawing systems; review; develop; working processes; function; quality; aesthetics; intentions; working practices □ *Present outcomes*: e.g. displays, e.g. drawings, maquettes, models, prototypes, photographs, video; design sheets; statements or written analysis; storyboards; stages of development; audio visual, e.g. digital presentation	□ Learners will show some ability to be able to produce models based on design work. The level of understanding of ergonomics addressed in the models will be basic and lack the depth shown in the higher grades. Evaluation will show a basic understanding of reviewing ideas and using findings to modify work in progress.

Information for tutors

Delivery

This unit focuses on the significance of design in relation to human physical needs. The majority of practical work should be related to particular areas of human need and consumption. Functional considerations will play a major part in design development and learners need to acquire a sufficient range of skills in this unit to enable them to progress in a chosen specialist area.

Learning outcome 1 can be delivered alongside learning outcome 2 through task-led exercises where learners consider the characteristics and properties of various materials in relation to human need in design. The opportunity exists for learners to make an evaluative study on a range of products from chairs to hand tools. In this way, learners may build up knowledge of how designers have used certain materials and why, considering factors such as strength and comfort. Learners should be taught to identify the factors of human need that have clearly determined the choice of materials, techniques and processes used in the making. They should also consider aspects of visual language such as sharp, soft, contrast, linear, pattern and so on. Learners will use investigative recording skills learned in other units where they will have explored and developed their visual language understanding. They will use their research recording to inform their design development and move into production of maquettes or model making. Learners should take great care to record all aspects of their design thinking and investigations in their sketchbooks or work journals, as this will form vital evidence for assessment.

In learning outcome 3 learners will use drawing systems to produce their ideas and communicate their intentions. Learners will need to be taught to use appropriate drawing systems confidently, such as freehand drawing, orthographic drawing systems, and CAD, if appropriate to the design brief or areas being studied. Learners' drawings should be clear and able to be used in presentations to target audiences, at a group critique for example, so they may need to explore a range of additional techniques such as using marker pens to highlight areas or provide three-dimensional effects to their drawing work.

Learning outcome 4 will be covered in part by the study undertaken in the other learning outcomes. As learners move through the unit, they should record their findings clearly and effectively. They should also use their sketchbooks or work journals to record their responses in reviewing their ideas and design proposals, and where appropriate showing how they have adapted or redirected the focus of their design work. This information, recorded accurately, will form a sound basis for learners to use in any presentations to others in the group. It will also provide the tutor/s with evidence for assessment detailing how much has been learned in addressing the key area of design for human need.

Assessment

The centre will devise and mark the assessment for this unit.

Learners must meet all assessment criteria to pass the unit.

Suggested resources

Textbooks

Bridger R S – *Introduction to ergonomics*, 3rd edition (CRC Press, 2008) ISBN 9780849373060

Buxton B – *Sketching User Experiences: Getting the Design Right and The Right Design – Interactive Technologies* (Morgan Kaufman, 2007) ISBN 978012374037

Fiell C and P – *Design of the 20th Century* (Taschen, 2005) ISBN 9783822840788

Fiell C and P – *Designing the 21st Century* (Taschen, 2005) ISBN 9783822848029
Hedge A – *Human Factors and Ergonomics for Design* (John Wiley and Sons Ltd, 2007) ISBN 9780471757993

Lefteri C – *Materials for Inspirational Design* (RotoVision, 2006) ISBN 9782940361502

Lidwell W – *Universal Principles of Design: 100 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Decisions and Teach Through Design* (Rockfort Publishers Inc, 2007) ISBN 9781592530076

Mills J W – *The Techniques of Sculpture* (Batsford, 1985) ISBN 9780713425093

Mitton M – *Interior Design Visual Presentation: A Guide to Graphics, Models and Presentation Techniques*, 3rd edition (John Wiley & Sons, 2008) ISBN 9780471741565

Newman T R – *Plastic as an Art Form* (Pitman, 1973) ISBN 9780273318637

Norman D A – *Emotional Design* (Basic Books, 2005) ISBN 9780465051366

Norman D A – *The Design of Everyday Things* (MIT Press, 1998) ISBN 9780262640374

Norman D A – *The Design of Future Things* (Basic Books, 2009) ISBN 9780465002283

Slack L – *What is Product Design?* (RotoVision, 2006) ISBN 9782940361243

Weizhi C – *Big Book of Creative Product Design* (Links International, 2008) ISBN 9788496969254

Journals and/or magazines

AN Magazine

Blueprint

Crafts

Creative Review

Design

Design issues

Make

Nest

Schmuck

Space

World of Interiors

Websites

www.burrows.com/found.html	Art and Crafts links
www.coshh-essentials.org.uk	Information to help firms comply with the Control of Substances Hazardous to Health Regulations
www.designcouncil.org.uk	The national strategic body for design
www.designboom.com/eng/education/rockingchair.html	Links and information on design
www.designobserver.com	Publications and articles about design
www.designthinking.ideo.com	Design blog
www.eyemagazine.com	Eye magazine online
www.intute.ac.uk/artsandhumanities/visual	Art and design links supported by several universities
www.vam.ac.uk	The Victoria and Albert museum website

13 Further information and useful publications

To get in touch with us visit our 'Contact us' pages:

Pearson Edexcel: www.edexcel.com/contactus

Pearson BTEC: www.btec.co.uk/contactus

Pearson Work Based Learning: www.pearsonwbl.com/contactus

Books, software and online resources for UK schools and colleges: www.pearsonschools.co.uk/contactus

Other sources of information and publications available include:

- *Pearson Equality Policy*
- *UK Information Manual* (Pearson)
- *Reasonable Adjustment and Special Considerations for BTEC and Edexcel NVQ Qualifications*
- *Recognition of Prior Learning Policy*
- *Quality Assurance Handbook* (updated annually)

Publications on the quality assurance of Pearson BTEC qualifications are available on our website at www.edexcel.com/quals/BTEC/quality/Pages/documents.aspx

Our publications catalogue lists all the material available to support our qualifications. To access the catalogue and order publications, please go to www.edexcel.com/resources/Pages/home.aspx

Additional resources

If you need further learning and teaching materials to support planning and delivery for your learners, there is a wide range of BTEC resources available.

Any publisher can seek endorsement for their resources, and, if they are successful, we will list their BTEC resources on our website at: www.edexcel.com/resources

14 Professional development and training

Pearson supports UK and international customers with training related to Pearson BTEC qualifications. This support is available through a choice of training options offered in our published training directory, or through customised training at your centre.

The support we offer focuses on a range of issues, including:

- planning for the delivery of a new programme
- planning for assessment and grading
- developing effective assignments
- building your team and teamwork skills
- developing learner-centred learning and teaching approaches
- building functional skills into your programme
- building in effective and efficient quality assurance systems.

The national programme of training we offer is on our website at: www.edexcel.com/training. You can request customised training through the website or you can contact one of our advisors in the Training from Edexcel team via Customer Services to discuss your training needs.

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Regional support: our team of Curriculum Development Managers and Curriculum Support Consultants, based around the country, are responsible for providing advice and support in centres. They can help you with planning and curriculum developments. If you would like your Curriculum Development Manager to contact you, please get in touch with your regional office on: 0844 463 2535.

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Whether you want to talk to a sector specialist, browse online or submit your query for an individual response, there's someone in our Pearson BTEC support team to help you whenever – and however – you need:

- Subject Advisors: find out more about our subject advisor team – immediate, reliable support from a fellow subject expert – at: www.edexcel.com/subjectadvisors
- Ask Edexcel: submit your question online to our Ask Edexcel online service www.edexcel.com/ask and we will make sure your query is handled by a subject specialist.

Annexe A

Mapping with NVQ/competence-based qualifications

The grid below maps the knowledge covered in the Pearson BTEC Level 3 Diploma in Automotive Clay Modelling (QCF) against the underpinning knowledge of the Pearson Edexcel Level 3 NVQ Award/Certificate/Diploma in Mechanical Manufacturing Engineering (QCF), Pearson Edexcel Level 3 NVQ Award/Certificate/Diploma in Business Improvement Techniques (QCF), Pearson Edexcel Level 3 NVQ Award/Certificate/Diploma in Engineering Leadership, Pearson Edexcel Level 3 NVQ Award/Certificate/Diploma in Engineering Maintenance (QCF), Pearson Edexcel Level 3 NVQ Award/Certificate/Diploma in Project Management (QCF), Pearson Edexcel Level 3 NVQ Award/Certificate/Diploma in Electrical and Electronic Engineering (QCF), Pearson Edexcel Level 3 NVQ Award/Certificate/Diploma in Engineering Technical Support (QCF). Centres can use this mapping when planning holistic delivery and assessment activities.

KEY

✓ indicates partial coverage of knowledge in the NVQ/competence-based qualification

A blank space indicates no coverage of the knowledge

Pearson BTEC Specialist units / NVQ/competence-based units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Unit 19
Level 3 NVQ in Mechanical Manufacturing Engineering	✓				✓	✓		✓											
Level 3 NVQ in Business Improvement Techniques		✓		✓															
Level 3 NVQ in Project Management					✓												✓	✓	✓
Level 3 NVQ in Electrical and Electronic Engineering									✓	✓									
Level 3 NVQ in Engineering Technical Support			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

February 2016

For information about Edexcel, BTEC or LCCI qualifications visit qualifications.pearson.com