Unit 98: Design for Moving Parts

Unit code: R/502/5374
QCF Level 3: BTEC National
Credit value: 10
Guided learning hours: 60

Aim and purpose

The aim of this unit is to develop learners' understanding of items and products that use motion and moving parts, through developing and producing their own work incorporating these features.

Unit introduction

Designers working in product and industrial design produce items that are designed to improve our lives in some way. This might be through enhanced vehicle design, ease of use in everyday objects, or simply to entertain us. They work through the design stages, clarifying the brief and identifying purpose, communicating ideas and concepts through 2D visualisations and producing prototype models. Many of these items use or incorporate moving parts. This aspect of design involves the appropriate use of components and mechanisms to transmit motion as required. In this context the designer is moving into industrial or engineering design, and this may well involve working in a team to realise the ideas. It is crucial for the designer to communicate intentions clearly in two and three dimensions. This type of design can relate to a range of working contexts including furniture, animation and special effects work alongside automotive, jewellery and other art and craft work.

In this unit, learners will be taught how to evaluate examples of selected items and products by professional practitioners that use motion and moving parts. In analysing these, learners will identify and list the different components that are used to transmit various types of motion. They will use the knowledge to design and produce an item or product that incorporates moving parts. This will involve them in constructing mechanisms such as gearings and considering how they function. They asked to work on a set brief, which may involve functional design, or equally result in the production of a piece of Kinetic art.

Learners will develop their visual skills to communicate ideas, concepts and intentions. They will produce a working model that incorporates moving parts and the transmission of motion. They will evaluate their work in progress during the development stages of the design process. As in the reality of professional industrial and product design, they will be asked to test the effectiveness of their design and model against the original design brief. Through this process, they will learn important facts about their working practice, analyse their results and gauge the value of their designed outcome.

Learning outcomes

On completion of this unit a learner should:

1 Understand how mechanisms transmit motion to moving parts

2 Be able to design models that use moving parts to a set brief

3 Be able to produce models that use moving parts to a set brief.

Unit content

1 Understand how mechanisms transmit motion to moving parts

Mechanisms: eg shafts, pulleys, cams, followers, wheels, gears, tensioned bands, weights, pawl and ratchet, screws, chains, rack and pinion, pedals, motors

Transmit motion: eg rotational motion, shaft-to-shaft motion, reciprocating motion, increase speed, decrease speed, steer, push, pull, winding, friction

Sources: primary, eg professional practitioners, visits, workshops, galleries, toy museums, museum; machinery, eg models of gears, drive mechanisms in machines, toys, wheels, cycles, working mills, turntables, vehicles, animatronics, kinetic art, performance; secondary sources, eg books, internet, diagrams, special effects, DVDs

2 Be able to design models that use moving parts to a set brief

Design models: eg consider brief, identify motion, sketch, render mechanisms, technical drawing conventions, orthographic projection, sectional drawings, details, use CAD, animation software

Design moving parts: eg functional requirements, motion required, shapes, forms, dimensions, aesthetics, materials for production, health and safety guidelines, maquettes, testing

3 Be able to produce models that use moving parts to a set brief

Produce models: eg interpret working drawings, cutting lists, schedule for production, forming, shaping, constructing

Use materials: eg wood, plastic, board, card, paper, fabric, metals

Use joining techniques: eg glueing, stapling, welding, cementing, split pins

Test motion: eg plan test conditions, manage test, record results, still photography, video

Evaluate successes and development areas: eg meeting the brief, use of materials, aesthetics, transmission of motion

Assessment and grading criteria

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

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 explain how mechanisms transmit motion to moving parts [IE, CT, RL, TW, SM, EP]	**M1** analyse how mechanisms transmit motion to a diverse range of moving parts	**D1** evaluate how mechanisms transmit motion to a comprehensive range of moving parts
P2 design models for a set brief incorporating motion through moving parts [IE, CT, RL, TW, SM, EP]	**M2** design effective models to a moving parts design brief	**D2** design sophisticated models that use moving parts to a set design brief
P3 produce a model to a set brief, demonstrating motion through moving parts. [IE, CT, RL, TW, SM, EP]	**M3** produce effective, detailed models that use moving parts to a set design brief.	**D3** independently produce innovative models that use moving parts to a set design brief.

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

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

Essential guidance for tutors

Delivery

This unit requires evidence of collaboration between the learner, the centre and the professional to investigate designs for moving parts, producing a final outcome to a set brief, working as an individual or as part of a team. Learners will be assessed on contextual research and analysis of mechanisms, that transmit motion to moving parts, on the communication of ideas for a design incorporating moving parts and on the successful 3D outcome to a set brief incorporating moving parts.

In this unit, learners should have the opportunity to analyse and learn about different types of motion. They should then use this knowledge and understanding to answer a specific design brief that requires design for moving parts. Finally, learners need to develop their design-based work and produce physical working models. They need to evaluate these against the original intentions and constraints in the design brief. This unit can be delivered using assignments devised for the learner working as an individual or as part of a team. The set brief can be internally devised, or issued by a client in a professional context, the latter supporting opportunities for cross-referencing evidence against professional specialist unit criteria. An external briefing will depend, to some extent, at what stage in the qualification delivery the project is scheduled; a basic level of understanding of 3D, product design and professional practice will assist confidence and ability to tackle set brief parameters in a client context. Briefs can be focused on functional objects, or on tasks that require problem-solving skills and enquiry, for example, how to raise an item up a given number of metres using a set list of materials. Reviewing a range of items and scenarios where learners can analyse and evaluate existing examples of design items that use moving parts may need to involve off-site visits.

For learning outcome 1, learners should analyse different examples of items and products that incorporate moving parts. These should be roughly in line with the parameters of the set project(s). Tutors may need to provide examples of mechanical motion as applied in small vehicles (prams, buggies, cycles, toys, animatronics (if available), turntables and seemingly simple items such as a litter picker's tool. This is not an exhaustive list; other examples should be included. Learners could be asked to each bring in an item from home to augment the tutor's resources. As learners are analysing the items they should identify the key components that make the motion: gears, pulleys, belts, cams, springs, winding mechanisms, shafts and so on. Learners should also record the type of motion these components are used to impart: reciprocal, shaft to shaft, rotational motion and so on. Ideas and observations should be recorded in their work journals, logs and sketchbooks.

For learning outcome 2, learners need to work to a set design brief that has clear constraints, aims and guidelines. The scope of this project will need to be defined by the tutor/s, possibly in conjunction with professional clients and take into account the range of resources and practical workshops available at the individual centre. Items could include the re-designing of a classic toy such as a spinning top, or a new interpretation of a traditional idea, for example the push-along car, consumer products such as a lever corkscrew or a pepper mill. Learners may wish to pursue larger scale projects such as folding buggies or similar items. In these cases the briefing guidance should make clear that a scaled version of the item is to be produced. Alternatively, it may be possible for learners to combine different aspects of motion and make a non-functional kinetic sculpture. Learners need to use a variety of drawing techniques to develop their ideas. Freehand drawing styles and conventions should be demonstrated to learners as a group.

Examples of designers' sketchbooks, working drawings or roughs would prove useful in showing learners how freehand and spontaneous their initial ideas could be. There are many of images on the internet, often in designers' CVs, to give learners an idea, although intellectual property rights (IPR) must be honoured. Development and design ideas should be recorded in sketchbooks, work journals or on design sheets. Orthographic projection and subsequent CAD or computer modelling may be incorporated into this part of the unit, again dependent upon available resources. Learners should record their progress through ongoing evaluation of their designs as set against the constraints of the brief.

For learning outcome 3, learners should carry their drawing and design ideas through to the production stage. They need to test their designs and how the motion is to be transmitted. This can be accomplished through initial working maquettes. Learners should be encouraged to make as many of the components as possible, as the translation from drawing to 3D is an important aspect of the unit. They may wish to combine motors, depending on the nature and scope of the design brief. Learners should record their progress as they are working up their models. Tutors may wish to provide a checklist for learners to refer to regarding this ongoing evaluation. It is important that learners remain focused on the original intentions and needs highlighted in the design brief. Learners should complete their working model, test it and record this using still photography or video. Learners should be encouraged to use reflective practice for process of analysis and evaluation of outcomes. They can then be able to conclude their evaluation by highlighting successes and development areas. Learners must adhere to and record applications to relevant health and safety guidelines and inductions.

Outline learning plan

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

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

Topic and suggested assignments/activities and/assessment
Group introduction to *Unit content* and potential activities (which may involve working with a client and/or in a team). Group introduction to, and discussion with, specialist tutors, clients and work–related assessment provider(s). Group planning for generic activities and resources in self-managed, directed, team and professional context.
Discuss and promote learner-initiated research, experimentation, evaluation and revision methodology, techniques and processes. Discuss the importance of and develop learner-directed methods for documenting research, experimentation, proposals, evaluations, revisions. Demonstrate the importance of learner-directed timelines established, to include research, experimentation, recordings, proposals, evaluations, revisions
Assignment 1: Analyse how Mechanisms Transmit Motion to Moving Parts Learners conduct research into mechanisms that transmit motion to moving parts, including examples of historical and contemporary designs for moving parts and some investigative experimentation using examples of designed moving parts. This will involve group work as well as working as an individual and will include discussions with peers and specialist tutors, alongside own appropriate research. Learners document and record discussions in a format for review and analysis and learner will produce a log of documents, diagrams and recordings that demonstrate useful analysis of motion to moving parts. Learners and tutors analyse and evaluate research and discuss sourced mechanisms, that transmit motion to moving parts.
Learner initiated study.

Topic and suggested assignments/activities and/assessment
Assignment 2: Develop and Communicate Ideas for a Design Incorporating Moving Parts Group consider a set brief for a design incorporating moving parts. Learners in groups discuss their initial ideas with peers and specialist tutors for design for moving parts, using sketches and basic 3D maquettes. Learners in groups develop ideas, producing sketches, concept models demonstrating use of materials, techniques and processes, for discussion and evaluation for purpose. Learners in groups present ideas internally to specialist tutors for ideas modification, using appropriate communication styles, techniques and processes. Tutors, assessors and clients will discuss and provide to learner, groups, interim guidance and feedback on development of ideas and concepts on which learners will produce assignment review log.
Learner-initiated study.
Assignment 3: Demonstrate, to a Set Brief, a Design Incorporating Moving Parts Learners communicate development work for a design incorporating moving parts through visuals, concept models and appropriate technical drawing conventions. Learners in groups discuss and agree revisions and confirm any variations with design group project manager, professional client, specialist tutors and peers Learners in groups reflect on information received and plan to implement development stage revisions and any agreed variations. Learners present design proposals, which include rendered visuals, technical/CAD scale representations of individual elements and a detailed working model of outcome, to demonstrate a design incorporating moving parts. Learners have taken guidance from professional clients, peers and specialist tutors, through one to one and group critiques, to influence proposals. Learner include health and safety references for working on designs, that include moving parts. Learners in groups produce a design analysis report including: • effectiveness and sustainability of design outcome • appropriateness of design outcomes for client and end users • time and resource management.
Learner-initiated study.
Review of unit and assessment.

Assessment

Work at pass level must show a response to the brief that produces appropriate work. Learners must list the components in mechanisms and explain how the motion is transmitted. Development work must be suitable for the design brief.

For P1, learners must understand how mechanisms transmit motion to moving parts. They will be able to explain the different functions of the components in the items they consider. They will communicate their understanding but may require input and guidance from tutors.

For P2, learners must design suitable models that use moving parts to a design brief. They need to design using components and types of motion that are relevant to the nature of the object or item to be made. They must demonstrate an appropriate use of design and drawing skills in communicating their intentions. They may require specialist tutorial guidance in the context of design and visual communication.

For P3, learners need to produce appropriate models that use moving parts to a design brief. They must work safely and demonstrate sound working practice in developing their work from 2D to 3D. Finishes and surface treatments must be suitable. Evaluations on successes and development areas will be clearly explained. Learners may require tutorial guidance and input to produce appropriate models.

Work at merit level should show an effective approach, with more attention to detail. The stages in the development of the design idea should be more independently reviewed and considered than at pass level work. Learners must demonstrate an effective range of skills and abilities in drawing and finalising their design. Work in the subsequent production stages must show some independence and be considered and purposeful.

For M1, learners must analyse how mechanisms transmit motion to a diverse range of moving parts and how they can use the components effectively in their design.

For M2, learners must design effective models that use moving parts to a design brief. Design proposals need to be effective in tackling the constraints of the design brief and independently worked. Learners must show a purposeful approach to design development work. Drawing and computer based work (if covered) must be consistent and communicate intentions effectively.

For M3, learners need to produce effective models that use moving parts to a design brief. They must work consistently when developing their ideas from 2D to 3D. Working practices need to be effective, purposeful and largely self-directed.

Work at distinction level must show a sense of innovation and originality. Learners must perform all the tasks within the assignment/s independently and confidently. The use of drawing, technology, equipment and processes must be sophisticated and informed.

For D1, learners must evaluate how mechanisms transmit motion to a comprehensive range of moving parts. They must make informed observations and judgements regarding mechanisms, components and movement. Their analysis should be perceptive and comprehensive.

For D2, learners must design sophisticated models that use moving parts to a design brief. Their work should be generally self-directed and show a fluency and sophistication in working up ideas through correct drawing conventions and additional technology. They must communicate their intentions through rendering in a sophisticated manner.

For D3, learners must independently produce original models that use moving parts to a design brief. Their use of materials, processes, technology and making methods need to be innovative and show informed understanding about the nature of the materials. Their use of movement and transmission of motion must be exciting, self-directed and sophisticated.

Programme of suggested assignments

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

Criteria covered	Assignment title	Scenario	Assessment method
P1, M1, D1	**Assignment 1**: Analyse How Mechanisms Transmit Motion to Moving Parts	Designer conducts research into mechanisms that transmit motion to moving parts.	Evidence log or workbook containing documents, sketches, diagrams, recordings and analysis.
P2, M2, D2	**Assignment 2**: Develop and Communicate Ideas for a Design Incorporating Moving Parts	3D designer works to a client brief for a design incorporating moving parts.	Portfolio of ideas for feedback and modification, using appropriate communication styles, techniques and processes. Assignment review log including proposed action on specialist guidance and feedback on development of ideas and concepts.
P3 M3 D3	**Assignment 3**: Demonstrate, to a Set Brief, a Design Incorporating Moving Parts	3D designer develops item incorporating moving parts, to a set brief.	Portfolio of Evidence incorporating moving parts visuals, concept models appropriate technical drawing conventions and CAD, working model of final outcome. Reflective practice model in development and analytical context for design for moving parts project. Health and Safety folder including electronic retrieval diagrams, standards and legislation, specifications and references.

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

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

Level 1	Level 2	Level 3
Introduction to 3D Design Products	Working in Spatial Design	Small-scale Design
Introduction to 3D Design Crafts	Working in 3D Design Crafts	3D Animation
	Working in Product Design	Human-scale Design

National Occupational Standards

This unit also provides development opportunities for some of the underpinning skills, knowledge and understanding of the following National Occupational Standards:

CCSkills Sector Skills Council

Design (revisions in draft form June 2009)

- DES5 Follow a design process
- DES24 Create 3D Models using a Computer Aided Design System
- DES38 Manage design realisation.

Essential resources

For design and production learners must have access to 3D design workshops for hand and machine tools. Provision of malleable and non-malleable materials is essential for learners' design experimentation, development and design outcomes.

Equipment for cutting, shaping, modelling, carving, forming, constructing and moulding and for digital working practice is essential.

Learners also require photographic or video equipment for recording purposes, which will include gathering primary source material and keeping a record of models, maquettes and work in progress.

Access to design studios for group teaching and evaluation sessions, including design ideas origination and development, is essential. Facilities with both specialist and general learning support materials, including books, journals and periodicals, are vital for research purposes. Computers with appropriately updated design software are required to support learners' digital ideas, technical development and expertise. Access to the internet is required for historical, cultural and contemporary contextual research.

Employer engagement and vocational contexts

Centres should develop links with practising artists, craftspeople and designers, to deliver assignments to learners or to provide work experience.

Links with employers are essential to the delivery of the programme for work experience and future employment.

Vocational learning support resources:

- Learning and Skills Network – www.vocationallearning.org.uk

Business and finance advice:

- local and regional Business Link – www.businesslink.gov.uk

Assignments should be vocationally relevant; centres should consider the delivery of 'live projects', for example, to support the vocational content of the unit and programme.

Creative and Cultural Skills (www.ccskills.org.uk), the Sector Skills Council for Arts, Crafts and Design, has launched the web portal Creative Choices (www.creative-choices.co.uk). This portal has a range of information about careers in the arts, crafts and design sector, including job descriptions.

Indicative reading for learners

Textbooks

Brown H – *507 Mechanical Movements: Mechanisms and Devices* (Dover Publications, 2005) ISBN 978-0486443607

Fiell C and Fiell P – *Industrial Design A-Z* (Taschen, 2006) ISBN 978-3822850572

Lidwell W, Holden K and Butler J – *Universal Principles of Design* (Rockport Publishers, 2007) ISBN 978-1592530076

Norman D A – *The Design of Everyday Things* (Basic Books, 2002) ISBN 978-0465067107

Onn A and Alexander G – *Cabaret Mechanical Movement: Understanding Movement and Making Automata,* (Cabaret Mechanical Publishing, 1998) ISBN 978-0952872900

Peppe R – *Making Mechanical Toys* (The Crowood Press, 2005) ISBN 978-1861267238

Pipes A – *Drawing for Designers: Drawing skills, Concept sketches, Computer systems, Illustration, Tools and materials, Presentations, Production techniques* (Laurence King, 2007) ISBN 978-1856695336

Journals

Crafts

Creative Review

Design Magazine

Design Week

Fine Scale Modeller

Modelmaker

Websites

www.core77.com	Core 77 design magazine and resource
www.designcouncil.org.uk	Design Council
www.designmuseum.org	Design Museum
www.modelshop.co.uk	4D model shop

Delivery of personal, learning and thinking skills

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

Skill	When learners are ...
Independent enquirers	planning and carrying out research into specialist projects
Creative thinkers	exploring the design process and generating ideas
Reflective learners	reviewing, reflecting on and evaluating their own and others' work
Team workers	collaborating with others to develop ideas, concepts, proposals, techniques and processes
Self-managers	organising time, planning resources, handling budgets when working to a specialist project brief, whether working their on own or as part of a design team
Effective participators	allowing for their own and others' requirements and proposals to be respected, considered, reviewed and actioned where appropriate.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	using digital means to develop designs
Troubleshoot	problem-solving mechanisms
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	presenting information about their designs
Present information in ways that are fit for purpose and audience	explaining ideas about models and moving parts
Mathematics	
Select and apply a range of skills to find solutions	developing and collating statistical data and creating scale drawings and models
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	analysing and evaluating research and including findings in presentations
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	evaluating items and final models
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching examples of others' work.