Unit 51: 3D Computer Modelling

Unit code: A/502/5241

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

● Aim and purpose

This unit is designed to allow 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, 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 in using 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.

● Learning outcomes

On completion of this unit a learner should:

1   Be able to set up, manage an navigate a computer model environment

2   Be able to create 3D objects and surfaces

3   Be able to use lighting and rendering

4   Understand how to develop computer models

Unit content

1 Be able to set up, manage and navigate a computer model environment

Set up: eg appropriate units and scale, grid size, colour, create and assign layers, coordinate system, origin point, toolbars

Manage: eg set and change work planes, assign model elements to layers, turn layers on and off, set up self-defined camera views

Navigate: eg 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: eg different processes in software (Maya, Lightwave)

2 Be able to create 3D objects and surfaces

Create 3D objects: eg box, sphere, cone, cylinder, prism, wedge torus, loft extrude 2D entities, revolve 2D entities

Modify and edit: eg dimensions, scale orientation, relocate object origin, move nodes (add, remove), Boolean operations (adding, subtracting and intersecting 3D entities), edges (add radii and chamfers)

3 Be able to use lighting and rendering

Use lighting: eg appropriate light (ambient, directional, spot, point, sky), light properties (set, edit, colour, intensity, cone), adjust (ambient, specular, diffuse components, control resolution, softness, shadows)

Rendering: eg 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)

4 Understand how to develop computer models

Analyse and evaluate: effectiveness eg 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: eg 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

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 set up, manage and navigate a computer model environment [SM]	**M1** effectively and competently manage the modelling environment and produce complex and accurate 3D computer models	**D1** demonstrate diverse knowledge and understanding of aspects of computer modelling, working independently to create imaginative models, presenting them in a range of formats.
P2 create 3D objects using tools and commands [CT]	**M2** demonstrate understanding of the advantages and limitations of the different 3D entities, tools and techniques employed in computer modelling	
P3 modify and edit 3D solids and surfaces [SM]	**M3** consistently and effectively use self-defined lighting and materials to create realistic or creatively rendered computer models.	
P4 use lighting and rendering to enhance computer models [IE]		
P5 review computer models [RL]		
P6 present own computer models.		

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

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. Assignment 3 in the outline learning plan details a scenario where 3D computer models can be used to present ideas to a client about the redevelopment of a bar and restaurant. 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 analyse and evaluate 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.

In order to generate assessment evidence it is essential that learners save regular versions of their work and make print-outs throughout the process. They should not save over or overwrite previous files.

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
Introduction to unit and structure of the programme – whole class.
Assignment 1: Exploring Shape and Form Introduction to assignment and tasks – tutor with whole class. Introduction to the software and tools – whole class then individual practice. Learners: - work through a series of exercises to explore the potential of the basic tools and functionality – tutor-led then individually produced worksheets, annotated sketchbook work, technical notes   - confirm understanding of basic tools and functionality – quiz.   - create a series of 2D shapes using appropriate tools assessed through saved work, sketches and recorded outcomes in notes   - alter and adapt shapes through addition, subtraction, deformation etc, save versions of work, record through drawings and notes   - develop shapes into 3D forms – layers, extrusions, save a series of views and make notes on outcomes   - translate a series of given shapes into computer models, make notes   - complete further self-directed practice to consolidate and extend learning, make notes and evaluate outcomes   - explain choices, resolve problems – discuss in one to one tutorials.   - analyse and evaluate results and write notes.
Assignment 2: Manipulating the Model Introduction to assignment and tasks – whole class Introduction to resources, lighting and rendering tools – whole class then individual practice. Learners: - navigate resources and select plug-ins, symbols etc, create own symbols and import to drawings. Assessed through saved work, notes   - experiment with lighting tools direction, shadows and save versions   - import textures, experiment with rendering tools and save versions   - experiment with viewpoint for 3D views, save views, assess results in notes/annotated sketches   - complete further self-directed practice to consolidate and extend learning, save versions, make notes to evaluate outcomes.   - explain choices, resolve problems – discuss in one to one tutorials   - analyse and evaluate results and write notes.

Topic and suggested assignments/activities and/assessment

Assignment 3: Live Project. Restaurant and Bar – Spatial Design

Introduction to assignment, location. Tutor/whole class.

Learners:

- visit location, survey space, interview client share findings, in groups and make sketches and notes
- do internet research of precedents, and individually write/illustrate a case study
- set up survey drawings as 2D computer drawings and save versions.
- designs and make/develop annotated sketches and computer drawings
- explain choices, resolve problems – discuss in one to one tutorials
- select final design and produce range of 2D and 3D drawings using appropriate computer modelling tools. Save work and make notes
- add lighting, texture/materials, import resources – walls, openings etc
- experiment with appropriate viewpoints select final drawings
- plan format for presentation to group, tutor, client print out electronic drawings and do a verbal presentation
- analyse and evaluate results in writing and verbally.

Assessment

For P1, learners need to set up, manage and navigate a computer model environment. They need to demonstrate their knowledge of individual components and their influences on the working environment and any subsequent modelling. Learners must to 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 P1 may be generated through witness statements, examination of settings on saved files and written evidence such as a technical file or written tests.

For P2, learners need to create 3D objects using appropriate tools and commands. They need to demonstrate awareness of the different object properties and be able to work with these to edit entities. Learners need to recognise tool icons and describe their functions.

For P3, learners need to edit and modify 3D solids and surfaces.

For P4, learners need to use different types of lights, render modes and materials to enhance computer models. They need to 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. Evidence for P2 and P3 may come from witness statements, learners' notes, written tests or saved files.

For P5, learners need to review their working methods and work in relation to that of others, in the broader context of current professional practice. They need to 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. Evidence may come from learners' notes, witness statements of group or one-to-one discussions or electronic and printed visuals.

For P6, learners need to present their 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.

For M1, learners should demonstrate competent control of the tools and settings that influence and control the working environment of modelling programmes. They should show confidence in the production of complex, creative and accurate computer models.

For M2, learners need to use the appropriate tools, techniques and model entities to demonstrate their understanding of the limitations and advantages of particular elements. They should articulate in any presentations or discussions with tutors or clients why they have employed certain techniques in their model work, and rejected others.

For M3, learners must consistently and effectively use the features associated with lighting and material properties to enhance their models during rendering. Evidence for merit criteria could come from saved files, learners' technical notes, printed images or certified observations of learners' practice.

For D1, learners should present an extensive body of work resulting from largely independent and self-initiated work. Learners are required to demonstrate extensive knowledge, and a high degree of competency in all areas of computer modelling and presenting finished work.

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 P2, M2	**Assignment 1:** Exploring Shape and Form	Designer exploring options within a brief.	Saved files. Printouts. Tutorial notes. Sketches. Technical notes. Quiz.
P2, M2, D1 P3, M3	**Assignment 2:** Manipulating the Model	Designer preparing visuals for a client.	Saved files. Print outs. Tutorial notes. Sketches. Technical notes.
P1, M1, D1 P2, M2 P3, M3 P4 P5 P6	**Assignment 3:** Live Project. Restaurant and Bar – Spatial Design	Designer working to a brief for new restaurant layout.	Presentation of visuals – electronic/printed. Sketchbook work. Technical notes. Tutor observation notes. Notes for presentation. Written self evaluation.

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 With 3D Design Briefs	Design Methods in Art and Design
	Working With Interactive Media Briefs	Computers in Art and Design
		Graphics for 3D Applications
		Small-scale Design
		Large-scale 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
- DES23 Create 2D Designs using a Computer Aided Design System
- DES24 Create 3D Models using a Computer Aided Design System

Skillset Sector Skills Council

Animation

- ANIM14 Set Up 3D Elements For Animation
- ANIM15 Create 3D Animation
- ANIM16 Render 3D Animation

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.

Employer engagement and vocational contexts

Centres should develop links with practising 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.

The Creative and Cultural Skills Sector is in need of designers with good presentation skills. These are addressed in several ways in this unit through both electronic and paper-based visuals and verbal presentation to the tutor and the whole group with the added possibility of presenting to an external potential client.

Creative skills are identified as a long term need for the sector and this unit aims to equip learners with a broad base of computer modelling skills to support design development in a range of 3D design specialisms.

Additionally, 3D computer modelling may lead to employment in its own right.

Creative and Cultural Skills (www.ccskills.org.uk), the Sector Skills Council for Arts, Crafts and Design have 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.

Skillset, the Sector Skills Council for Creative Media (www.skillset.org), provides details (www.skillset.org/careers) on careers and the industry and has plus a regularly updated news and events page.

Indicative reading for learners

Textbooks

Bousquet M and McCarthy M – *3ds Max Animation with Biped* (New Riders, 2006) ISBN 978-0321375728

Hachigan J and Jerrard D – *Lightwave 3D Applied* (Wordware Publishing, 2005) ISBN 978-1556222917

Jacobs S – *Computer-aided-design Design Studio: 3D Modelling as a Fundamental Design Skill* (McGraw-Hill Education, 1991) ISBN 978-0070322271

O'Rourke M – *Principles of Three-Dimensional Computer Animation: Modeling, Rendering and Animating with 3D Computer Graphics* (W W Norton & Co, 1998) ISBN 978-0393730241

Summers D – *Texturing: Concepts and Techniques* (Charles River Media, 2004) ISBN 978-1584503002

Journals

Computer Graphics World

Websites

www.CGW.com   Computer Graphics World Magazine

www.skillset.org   The Sector Skills Council for Creative Media

Delivery of personal, learning and thinking skills

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

Skill	When learners are …
Independent enquirers	using lighting and rendering effectively to enhance computer models
Creative thinkers	creating 3D objects, modifying and editing 3D solids and surfaces using appropriate tools and commands
Reflective learners	effectively analysing, evaluating and presenting computer models
Self-managers	setting up, managing and navigating a computer model environment

creating 3D objects, modifying and editing 3D solids and surfaces using appropriate tools and commands. |

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

Skill	When learners are …
Independent enquirers	using research to explore appropriate applications for 3D modelling

justifying decisions made with evidence |
| **Creative thinkers** | developing and adapting ideas based on results

problem solving to address unexpected outcomes |
| **Reflective learners** | keeping a reflective log on their own progress and development

considering their own strengths and areas for improvement and suggesting ways forward |
| **Team workers** | working in a group to share research and taking responsibility for their own contribution

managing discussions to reach agreement and achieve results |
| **Self-managers** | managing and prioritising their own workload within specified time frames

managing resources

communicating to audience of peers and tutors |
| **Effective participators** | contributing to group discussions and group brainstorming sessions. |

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 a range of 3D modelling tools to achieve desired outcomes
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	identifying outcomes and planning access to required, shared resources
Manage information storage to enable efficient retrieval	saving layers and views
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	importing textures and material visuals etc for rendering using library of prepared symbols, details etc
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching on the internet or accessing programme help files
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 2D visuals with supporting text and/or numeric information
Bring together information to suit content and purpose	implementing and modifying project plans as required to achieve outcomes
Present information in ways that are fit for purpose and audience	modifying and re-presenting information in support of analysis and evaluation of their own and others' work
Evaluate the selection and use of ICT tools and facilities used to present information	analysing and evaluating the success of specific outcomes
Mathematics	
Identify the situation or problem and the mathematical methods needed to tackle it	planning to model actual or pre-defined objects and gathering relevant measurements
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	group critiquing their own and others' work
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	accessing internet research and programme help files
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	writing project evaluations or documents in support of a formal presentation presenting interim and final outcomes.