Unit 68:   3D Environments

Unit code: **A/600/6599**

QCF Level 3:   **BTEC National**

Credit value: **10**

Guided learning hours: 60

● Aim and purpose

The aim of this unit is to introduce learners to the theory and use of 3D environment software. Learners will develop an awareness of how 3D environments function and devise and create a 3D environment scene and reflect critically on their own work.

● Unit introduction

3D environment artists create 3D environments for architectural walk-throughs, TV programmes, films, websites and games. The scenery created by these artists includes, for instance, buildings, vegetation and furniture produced by computers running 3D application software. 3D environment artists are responsible for applying textures to objects and environment items such as the surfaces of walls and floors of buildings. This is a highly skilled area of work which requires considerable knowledge and understanding of lighting, perspective, materials, colour theory and visual effects. Specialist software packages are used to create the environments and work must be done in an efficient and effective way which makes best use of the technology.

In this unit learners will have the opportunity to use a 3D software application to produce a 3D scene of an environment. This is a complex process and learners are encouraged to research the concepts and use of 3D environments within the media industry. Learners will develop an awareness of how rendered 3D environments are displayed on screens. An appreciation of the geometric theory underlying 3D work will help learners understand the technical language used by environment artists.

Through following this unit, learners will develop practical computer skills that will enable them to create original 3D environments using a range of techniques, including lighting, texturing and rendering. They will have an opportunity to devise and develop original ideas from interpreting creative briefs for potential target audiences and will develop preparation skills such as drafting pre-visualisation sketches and storyboards.

This unit will develop learners' ability to reflect critically on their own work, as they will need this professional skill in any future career. Planning and self-evaluation are also professional skills and developing them will form a habit of preparation and workflow management which will be valuable to any entrant to the interactive media industry.

Learning outcomes

On completion of this unit a learner should:

1   Understand theory and applications of 3D

2   Be able to devise a 3D environment

3   Be able to create a 3D environment following industry practice.

Unit content

1   Understand theory and applications of 3D

Applications of 3D: eg environments, models, product design, TV, film, web, games, education, architectural walk-through

Displaying 3D polygon environments: application programming interface; graphics pipeline, eg modelling, lighting, viewing, projection, clipping, scan conversion, texturing and shading, display; rendering techniques (radiosity, ray tracing, photon mapping); rendering engines; distributed rendering techniques; lighting; textures; fogging; shadowing; vertex and pixel shaders; level of detail

Geometric theory: vertices; lines; curves; edge; polygons; element; face; primitives; meshes, eg wireframe; coordinate geometry (two-dimensional, three-dimensional); surfaces

Mesh construction: box modelling; extrusion modelling; using common primitives, eg cubes, pyramids, cylinders, spheres

3D development software: software; file formats; plug-ins

Constraints: polygon count; file size; texture size; rendering time

2   Be able to devise a 3D environment

Stimulus: eg client brief, own brief, from market research

Ideas: brainstorming; sketches; pre-visualisation (concept drawings, storyboards, level diagrams, 2D and 3D architectural drawings)

Legal and ethical considerations: legal, eg copyright; ethical, eg confidentiality, decency; representation, eg race, gender, religion, sexuality

Specification: target audience; key visual themes; storyboards*;* constraints, eg polygon count, image resolution, output size, file type, file size

3   Be able to create a 3D environment following industry practice

Plan: asset management (file storage and retrieval, naming conventions); workflow (scheduling, efficient time management); deadlines (production milestones, deliverables, quality assurance)

Software interface: files, eg loading, properties, merging, replacing, importing, saving, backup, auto-saving; viewports, eg configuring viewports, viewport controls; command panels; keyboard shortcuts; floating palettes; customising the interface; floating toolbars; drawing units; drawing aids (layers, grids, snap); object naming conventions

Virtual camera: concepts, eg lens length, field of vision (FOV), focus and aperture, depth of field, camera movement; cameras, eg creating a camera, creating a camera view; camera parameters; camera type, eg target, free

Lighting techniques: light types, eg ambient, distant, area, spot, point, linear, photometric, raytraced; lighting controls and effects, eg projector, attenuation, colour, shadows; atmospheric, eg clouds, smoke, fire; volumetric, eg fog, mist

Texturing techniques: texturing process, eg creating, loading textures, applying textures; using materials, eg materials editor, mapping materials, material modifiers; material types, eg bitmap, procedural, using avi video files as textures

Rendering: scene rendering, eg rendering controls, rendering options, output size and aspect ratio, safe-frame, file type, file size; image resolution, eg TV, film, web

Industry practice: reflect on finished product (compared with original intentions, fitness for purpose, technical qualities, aesthetic qualities); production skills (ideas generation, environment specification, workflow and time management, technical competence, teamwork)

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 summarise accurately theory and applications of 3D with some appropriate use of subject terminology [IE]	**M1** explain theory and applications of 3D with reference to detailed illustrative examples and with generally correct use of subject terminology	**D1** comprehensively explain theory and applications of 3D with elucidated examples and consistently using subject terminology correctly
P2 generate outline ideas for a 3D environment working within appropriate conventions and with some assistance [CT; SM]	**M2** generate detailed ideas for a 3D environment showing some imagination and with only occasional assistance	**D2** generate thoroughly thought-through ideas for a 3D environment showing creativity and flair and working independently to professional expectations
P3 create a 3D environment following industry practice, working within appropriate conventions and with some assistance. [CT; SM; RL]	**M3** create a 3D environment to a good technical standard following industry practice, showing some imagination and with only occasional assistance.	**D3** create a 3D environment to a technical quality that reflects near-professional standards following industry practice, showing creativity and flair and working independently to professional expectations.

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

It is suggested that teaching follows the order of the learning outcomes, addressing the concepts and principles of 3D initially, followed by generating ideas and planning and production of original 3D environment.

This unit could be taught through a variety of activities, such as lectures, group discussions, practical sessions and demonstrations. The largest proportion of time should be spent in practical sessions using 3D application software.

Lectures and independent study may be the main methods used to teach understanding of concepts and principles of 3D. Learners could research a range of contemporary 3D environment work and investigate how professional 3D environment artists incorporate their work into a range of media products.

Learners will need to appreciate the application of 3D and the principles of 3D geometric theory, mesh construction and the development of 3D outcomes. They will therefore need to understand the features of 3D application software and the techniques and methods used in the development of 3D environments. This can be achieved through a combination of formal lectures, independent study or through the practical use of 3D software to create 3D environments. Learners will also need access to a range of 3D design tools and plug-ins.

Teaching of 3D application software is best done in short, carefully structured stages, each stage being reinforced with small practical tasks which, when completed, allow progress to other stages.

Learners must produce a 3D environment to a brief that could be specified by a client or be a simulated assignment. This will develop knowledge, skills and techniques associated with using industry-standard 3D software to produce environments.

Reflective practice is an important part of development and design. Learners should be encouraged to compare their completed 3D environments with their original intentions and with current and past professional work for development and refinement.

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 of planning the teaching and assessment of this unit.

Topics and suggested assignments and activities
Introduction to unit and unit assessment.
Introduction to concepts and principles of 3D. Learners will receive lectures and demonstrations, and hold discussions to: • examine how 3D is used by the interactive media, film, animation and computer games industries • explain how 3D environments are displayed • explain how 3D environments are constructed • examine the types of development software used in the production of 3D environments.
Assignment 1 – 3D: the Basics Learners write an article entitled '3D: the basics' for an online 3D art ezine, examining the application and use of 3D models within interactive media and computer game products. The article must cover: • applications of 3D • displaying 3D polygon animations • geometric theory • mesh construction • 3D development software • constraints.
Introduction to and review of ideas generation and recording.
Assignment 2 – Ideas Generation Brief is to generate ideas and specification documentation for a 3D environment for an architectural walk-through of a building. Learners will work individually to: • consider and interpret the creative brief • generate and record ideas • carry out pre-production planning • compile a comprehensive development log evidencing their creative work.
Sessions on development of practical web animation skills, with brief introductory lectures, covering: • basic software interface tools • advanced software interface tools • environment production processes • reviewing own 3D environment production work.

Topics and suggested assignments and activities
Assignment 3 – Production
Following on from the work for Assignment 2, learners will create the 3D environment they have planned.
Learners will:
• undertake production workshop sessions following their planned ideas
• present 3D environment production work.
Unit learning and assessment review.

Assessment

Evidence for assessment

Evidence for assessment of learning outcome 1 could be a presentation, blog, vlog or report explaining the applications of 3D, geometric theory, mesh construction, 3D development software and constraints. Research could include extracts from books, journals, articles, material published on the internet or trade publications.

This unit can be combined with other units that require 3D production.

For learning outcomes 2 and 3 learners must work to a given brief to produce documentation showing ideas generation and planning, and a 3D scene of an environment using 3D application software. Documentation could be presented in forms such as annotated screen grabs or via screen capture software with voiceover.

Presentations must be recorded for the purposes of internal and external verification.

For some elements of this unit, and for some learners, a formal viva voce assessment might be appropriate. When more than one learner in a cohort is assessed in this way, care must be taken to ensure that all learners are asked equivalent questions, and that all are given equal opportunities to expand or clarify their answers. Interviewers must also ensure that questions are not phrased in such a way as to provide or suggest an answer. Formal vivas should be recorded for the purposes of internal and external verification and at least 50 per cent of such assessments must be internally verified.

Application of grading criteria

When applying the grading criteria tutors should follow the advice given below. Please note that any examples of evidence given here are indicative only. This advice is not inclusive and the examples need not be included in a learner's work in order for that learner to achieve the exemplified grade. For each of the criteria learners must present evidence that addresses each italicised sub-heading of the content for the learning outcome.

Pass

To achieve a pass grade, learners must achieve all the criteria at pass level. For each of the criteria learners must present evidence that addresses each italicised sub-heading of the content for the learning outcome.

P1: learners will describe the use of 3D within the interactive media industry and how 3D graphics are displayed; including reference to geometric theory and mesh construction, though will typically not discuss displaying 3D polygon environments. The description will not be related through examples to particular 3D applications. Descriptions of geometric theory and mesh construction will be correct and cover the main points. A pass grade learner might note when discussing geometric theory, 'Points are the most basic part of every 3D object. The joining of points creates lines, which in turn can then be made into polygons. Points are used to identify a place or location in 3D space. Once you have your points, you can connect them to make a line.' Evidence will show a basic understanding of technical terminology but learners will generally be unsure about this vocabulary and will make fairly frequent mistakes when they do use it.

P2: learners will indicate some consideration of brief or target audience, though this is likely to be a basic statement of fact, without discussion of implications. Evidence will show some ideas generation outlining ideas through brainstorming sheets, sketches, storyboards or otherwise, though they will not justify choice of final ideas for implementation. There will be some imagination behind the ideas and some attempt will have been made to clarify intentions but this will be patchy and not always clear. Learners will outline the idea and give some indication of what will be required to create the 3D environment scene. They will also show that they have taken account to some extent of legal and ethical considerations though this evidence is likely to be minimal and factual only, lacking consideration of implications for the final 3D environment scene.

P3: learners will produce a 3D environment scene from ideas generated from their interpretation of the brief. For this grade the learner's use of the 3D application software to produce their 3D environment scene will be basic, typically using ambient, distant, area and spot lighting types, adding a target virtual camera, applying basic textures to objects and basic scene rendering techniques. Learners will provide documentation on their use of the 3D application software tools and features employed but it will lack in detail. Outcomes will show some use of industry practice for development and refinement of outcomes.

P2 and P3: in terms of the imaginative qualities of their work, pass grade learners will not move beyond the conventional, but the conventions applied will be appropriate to the form or genre within which they are working. Learners working at this grade will have required frequent assistance and support from tutors to prepare and create their 3D environment ideas. If they have been in frequent need of such help but fail to make use of it, they should not be considered for a pass grade for this unit.

Merit

To achieve a merit grade, learners must achieve all the pass and all the merit grade criteria. For each of the criteria learners must present evidence that addresses each italicised sub-heading of the content for the learning outcome.

M1: learners will correctly explain the use of 3D within the interactive media industry and how 3D graphics are displayed, including explanation of geometric theory and mesh construction. The evidence will include detailed illustrative examples but they will not be elaborated to show how they illustrate the points being made. A merit grade learner might note, when discussing geometric theory, 'Points are the most basic part of all 3D objects, also known as vertices. The joining of vertices creates lines known as edges. When you connect three or more lines together you have an area which is closed, making a face known as a polygon. Diagram X shows how four points are defined using the Cartesian coordinate system. When connected together the area closed within the lines is called a face otherwise known as a polygon.' Learners will use technical vocabulary for the most part correctly, but may make mistakes or be unsure about usage at times.

M2: learners will generate and plan a 3D environment project which combines the key characteristics of 3D environment in an imaginative way, making use of conventions but not slavishly copying them. Evidence will reveal imagination beyond the conventional, an organised approach to ideas generation and planning and clear explanations of intentions. Evidence is likely to be a portfolio or presentation including brainstorming sheets, sketches, and storyboards or otherwise within a final specification document presented as a final proposal suitable for use by another to prepare the product. Merit grade learners will indicate consideration of brief or target audience; this will include discussion of implications. There must be evidence which indicates an awareness of legal and ethical constraints, with some consideration of their implications for the final product.

M3: learners will produce a 3D scene from ideas generated through their interpretation of a brief. For this grade the learner will use the 3D application software competently to produce their 3D scene, typically employing ambient, distant, area, spot, photometric and raytraced lighting types, lighting controls and effects, atmospheric and volumetric lighting, adding a target virtual camera and applying camera parameters, creating, loading and applying textures to objects, using the materials editor to modify and map materials and scene rendering to client brief requirements. Learners' outcomes will show competent consideration of software tools and the features employed, fitness for purpose (considering the client brief where relevant and target audience), application of techniques to the generation of ideas, and planning of the 3D environment. Outcomes will show competent use of industry practice for development and refinement of outcomes.

M2 and M3: though learners might still be working within recognisable generic conventions, there will be some thought behind the application of technical skills, and codes and conventions will be used with some inventiveness. Learners working at this grade will have required limited assistance from tutors to prepare and produce their 3D environment ideas, particularly when dealing with more complex technology or trying to apply more sophisticated techniques. As with the pass grade learner, they will benefit from such assistance.

Distinction

To achieve a distinction grade, learners must achieve all the pass, all the merit and all the distinction grade criteria. For each of the criteria learners must present evidence that addresses each italicised sub-heading of the content for the learning outcome.

D1: learners will explain fully and clearly the use of 3D within the interactive media industry and the ways in which 3D graphics are displayed, including consideration of geometric theory and mesh construction, using explicit examples of particular 3D objects to provide clear explanation of the points being made. They will justify points made using supporting arguments or evidence and draw out of an example precisely what it is about it that exemplifies the point it illustrates. Fuller and more extensive explanation, the better application of examples and provision of argument to support points made will discriminate between this grade and the merit. A distinction grade learner might note when discussing geometric theory, 'Points are the most basic part of all 3D objects known as vertices. The joining of vertices creates lines known as edges. When you connect three or more lines together you have an area which is closed, making a face known as a polygon. More complex polygons can be created out of multiple triangles, or as a single object with more than three vertices. Triangles are the most common shapes used in polygonal modelling. A group of polygons which are connected by shared vertices is referred to as a mesh. Diagram XX shows how four points are defined using the Cartesian coordinate system. When connected together the area closed within the lines is called a face, otherwise known as a polygon.' Technical vocabulary will be secure and used correctly and confidently at all times.

D2: learners will work independently to prepare a final specification document, report or presentation including brainstorming sheets, sketches, and storyboards or otherwise. This will be presented as a final specification suitable for use by another to prepare the 3D environment scene. Learners will demonstrate a consideration of brief or target audience which will include a reasoned and justified discussion of implications. Evidence will demonstrate creativity and flair with an organised approach to ideas generation and planning, and all decisions and intentions will be clearly explained. Distinction grade learners will justify the choice of final ideas for implementation. There will be evidence which indicates a thoughtful consideration of the effects of legal and ethical constraints upon the final 3D environment scene.

D3: learners will produce a 3D scene showing creativity and flair, drawing clearly on their interpretation of the brief and the ideas generated. They will use the 3D application software with confidence and autonomy to produce their 3D scene – for example, ambient, distant, area, spot, photometric and raytraced lighting types, lighting controls and effects, atmospheric and volumetric lighting, adding a target virtual camera and applying camera parameters, creating, loading and applying textures to objects, using the materials editor to modify and map materials and scene rendering to client brief requirements. Learners outcomes will show effective consideration of software tools and the features employed, fitness for purpose (considering the client brief where relevant and target audience), application of techniques to the generation of ideas, and planning of the 3D environment.

D2 and D3: learners will apply their technical skills not just with imagination but with ingenuity and even elegance, and codes and conventions will be used with occasionally surprising results. In all practical activity distinction grade learners will be capable of working autonomously and effectively. The term 'working independently' means that they are able to work on their own initiative, do not need constant support or supervision, give the work their full commitment, work positively and cooperatively with others and meet deadlines. In other words, they have the kind of self-management skills that would be expected of them in a professional context. Note also that this criterion should not be taken to mean that learners do not seek advice or that they work without discussing things with their tutor, but rather that they are not dependent upon the support of others and that if they take advice they weigh it carefully for themselves.

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 Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, M1, D1	Assignment 1 – 3D: the Basics	Article on 3D modelling for an online 3D art ezine.	• All preparatory notes. • Ezine article.
P2, M2, D2	Assignment 2 – Ideas Generation	Brief from client to create a 3D environment for an architectural walk-through of a new building.	Development log, blog or vlog containing: • all ideas notes, sketches, concept drawings, storyboards • proposal outline • environment specification.
P3, M3, D3	Assignment 3 – Production	As above.	Project portfolio containing: • planning notes • all production documentation • 3D environment • personal reflective commentary.

Links to other BTEC units

This unit forms part of the BTEC Creative Media Production suite. This unit has particular links with the following units in the BTEC Creative Media Production suite:

Level 2	Level 3
	3D Animation
	3D Modelling
	Computer Game Engines
	Digital Graphics for Interactive Media
	Drawing Concept Art for Computer Games

Essential resources

Learners must have access to 3D development software and internet access to download plug-ins.

Employer engagement and vocational contexts

Centres should develop links with local games and graphic design studios which could be approached to provide visiting speakers, study visits or samples of typical artwork.

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	generating ideas for a 3D environment to be used in an interactive context
	carrying out research into theory of 3D environment and its application
	carrying out research to develop ideas for their own 3D environment scene
Creative thinkers	trying out different ways of creating their 3D environment, following ideas through to complete a 3D environment scene
	adapting their ideas as circumstances change
Reflective learners	reviewing and reflecting on their 3D environment work and acting on the outcomes to modify and improve their work
	setting goals with success criteria for their production work
	inviting feedback on their own work and dealing positively with praise, setbacks and criticism
	evaluating their learning and experience to inform future progress
Self-managers	producing a 3D environment to be used in an interactive context
	seeking out challenges or new responsibilities and showing flexibility when circumstances change
	dealing with competing pressures, including personal and work-related demands
	responding positively to change, seeking advice and support when needed.

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 …
Team workers	if working in a group to produce a 3D environment, taking responsibility for their own role
	managing their personal contribution to and assimilating information from others in discussions to reach agreements and achieve results.

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	handling 3D environment systems to create their 3D environment scene
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	planning for the 3D environment of their 3D animated sequence
Manage information storage to enable efficient retrieval	managing assets sourced and created for their 3D environment scene
Follow and understand the need for safety and security practices	handling 3D environment systems to create their 3D environment scene
Troubleshoot	handling 3D environment systems to create their 3D environment scene
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	sourcing assets for their 3D environment scene
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching asset types and their limitations for use with their 3D environment scene
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	building and presenting their project portfolio showing their interpretation of the brief, generation of ideas, documenting the management of their chosen assets, considering legal implications and reviewing their own work
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	
Evaluate the selection and use of ICT tools and facilities used to present information	preparing a report on 3D environment tools and how 3D environment rendering is used
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	gathering feedback on their 3D environment work as part of their self-reflective practice

Skill	When learners are …
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	using coordinate geometry to create 2D and 3D environment models
Identify the situation or problem and the mathematical methods needed to tackle it	
Select and apply a range of skills to find solutions	
Use appropriate checking procedures and evaluate their effectiveness at each stage	
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	
Draw conclusions and provide mathematical justifications	
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	taking part in brainstorming sessions to generate ideas as a response to a creative brief
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	studying manufacturers' manuals to research 3D environment software
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	creating their project portfolio with ideas, notes, production documentation and reflective comment.