GLOSSARY

THE WORLD OF 3D HAS ITS OWN UNIQUE JARGON.

3D
Three-dimensional. Descriptive of a region of space that has width, height and depth.

Algorithm
A procedure or formula for solving a mathematical problem. Algorithms are commonly used for such tasks as generating textures, rendering images and controlling mathematically based behaviour patterns.

Alpha Channel
The top byte of a 32-bit pixel that is used for data other than colour. The alpha channel commonly holds mask data, enabling an image to be separated from its background for use in compositing.

Ambient Light
An artificial illumination level representing infinite diffuse reflections from all surfaces within a 3D scene, ensuring that even surfaces without direct illumination become visible to the user.

Animation
A medium that creates the illusion of movement through the projection of a series of still images or 'frames'. The term is also used to refer to the techniques used in the production of an animated film - in 3D animation, primarily those controlling the motion of the objects and cameras within a scene. These include keyframe animation, in which the artist sets the positions of objects manually at certain key points in the action, and the computer calculates their intervening positions through a process of interpolation or 'in-betweening', and procedural animation, in which the motion is controlled automatically via a series of mathematical formulae.

Animatic
A rough animation that is used by animators to give some idea about the timing of a sequence, used as a kind of animated storyboard.

Anti-aliasing
A method of reducing or preventing rendering artefacts by using colour information to simulate a higher screen resolution. The term is often applied to the process of softening the unnaturally precise or stepped edges (sometimes known as 'the jaggies') created when a computer-generated object is placed against a contrasting background by using pixels of intermediate shades as a buffer between the two.

Aperture
In a real camera, the size of the opening that light passes through (usually given in terms of its f-stop) in order to reach the film. The larger the f-stop, the smaller the opening. 3D software packages sometimes mimic the effects of different aperture settings on a recorded image during the rendering process.

Aspect Ratio
The ratio of the width of an image to its height. Common aspect ratios for broadcast images include 4:3 and 16:9 (widescreen).

Axis
A hypothetical linear path around which an object can be rotated, or across which it can be mirrored. In the Cartesian co-ordinate system, the three world axes, X, Y and Z (width, height and depth) define directionality within the 3D universe. Hence, a co-ordinate of (0,0,0) defines the origin of the world.

Beauty Pass
When rendering multiple passes of a scene, the beauty pass is the one that features the most significant information about the objects within it. This usually includes the main, full-colour rendering of those objects, including diffuse illumination and colour. A beauty pass will not include reflections, highlights, and shadows, which are usually separate passes.

Bit Depth
The number of bits used to define the shade or colour of each pixel in an image, a 'bit' being the smallest unit of memory or storage on a computer. (One 'byte' is eight 'bits'.) A 1-bit image is black and white. An 8-bit image provides a 256-colour palette. A 24-bit image provides 16.7 million possible colours: a palette sometimes known as 'True Colour'. A 32-bit image provides the same palette, plus an 8-bit greyscale alpha channel.

Bitmap
Strictly speaking, a bitmap is a 1-bit black-and-white image. However, the term is often loosely applied to any two-dimensional image, regardless of bit depth. Still image manipulation packages such as *Photoshop* and *Paint Shop Pro* are sometimes referred to as 'bitmap editors'.

Blinn See: Shading.

Bluescreen Footage
Live footage shot against a backdrop of a single uniform colour (usually blue or green) with a view to compositing it into a computer-generated background. Every pixel with the same colour value as the backdrop is replaced by the CG image.

Bone
A rigid object analogous to a real bone, placed inside the 'skeleton' of a character during the process of rigging it for animation. When a bone is moved, it acts upon the mesh of the character model, deforming it.

Boolean
An object created by combining two objects using mathematical operators. The two objects may be subtracted from one other, merged, or intersected to form the new object.

Bounding Box
The smallest regular-shaped box that encloses a 3D object, usually rectangular in shape.

Bump Map
A black-and-white image used by a 3D software package to simulate the three-dimensional detail on the surface of an object. When projected over the surface of the object, parts of the surface beneath white areas of the image are raised; those beneath black areas are depressed. Bump mapping is purely a rendering effect, however, and does not affect the underlying geometry of the model.

CAD
Computer Aided Design. The use of computer-based models of objects for visualisation or testing as an aid in the design process. CAD software packages usually contain more precise real-world measuring tools than ordinary 3D packages, but fewer surfacing and animation features.

Camera
A virtual viewpoint in 3D space that possesses both position and direction. In a 3D scene, the camera represents the viewer's eye. When the scene is rendered at final quality, it is the camera view that is used, rather than the one seen in the software's

HERE ARE CONCISE DEFINITIONS OF SOME OF THE MAIN TECHNICAL TERMS YOU MAY ENCOUNTER

workspace. This enables the artist to move around the workspace without disturbing the camera view.

Camera Mapping
A technique by which geometry matching the size and perspective of objects shown within a still image is constructed, and the original image mapped back onto those objects. This permits limited camera movement around the picture, giving the illusion of a 3D environment from a 2D image.

Camera Move
A movement of the virtual camera within a 3D software package analogous to one in real-world cinematography. Common camera moves include dollying, in which the camera angle remains fixed, but the camera moves towards or away from the subject; panning, in which the camera position remains fixed, but the camera tilts or swivels in any direction to follow the action; and tracking, in which the camera moves in a single plane at right angles to the area of interest.

Camera Path
The path in virtual space along which the camera moves during the course of an animation.

Camera Tracking
Also known as match moving, camera tracking is the process of 'extracting' the motion of the camera in space from a piece of live-action footage. This motion data can then be imported into a 3D software package and used to animate the virtual camera, in order to better match the rendered output to that of the source footage during the compositing process.

Caustics
Patches of intense illumination caused by the refraction of light through a transparent object or the reflection of light from a reflective surface. One common example

would be the shifting patterns of light and shade cast on the floor of a swimming pool on a sunny day. Rendering software has only recently become sophisticated enough to mimic such complex real-world lighting effects as caustics.

CGI
Computer Generated Imagery. An image or images created or manipulated with the aid of a computer. The term is often used to refer specifically to 3D computer animation, although it is really more widely applicable.

Channel
For a two-dimensional image, a channel is a sub-image composed only of the values for a single component of a given pixel. A greyscale image has one colour channel, an RGB image has three, and a CMYK image has four. When applied to materials, the term refers to one particular subset of the properties which determine the way in which a surface reacts to light, including colour, reflectivity, transparency, diffusion, specularity and bump.

Character Animation
A sub-area of animation that deals with the simulation of the varied movements of living creatures. Usually, before a character model can be animated, it must be set up with an underlying skeleton, constraints and controllers: this process is known as rigging.

Child See: Hierarchy.

Colour Bleeding
A physical phenomenon by which the colour of one object is seemingly transferred to a neighbouring object by light bouncing from one surface to the other. Like caustics, colour bleeding is a complex real-world lighting effect, and one that rendering software has only recently become able to simulate accurately.

Colour Space
A mathematical method for defining the way in which colour is represented within an image. Common colour spaces include RGB (Red, Green, Blue), which has a bit depth of 24, and is commonly used in broadcast applications, and CMYK (Cyan, Magenta, Yellow, Black), which has a bit depth of 32, and is used for print illustration work.

Compositing
The process of combining multiple images into a single image. This is often performed in films to make a live actor appear on a computer-generated background, or vice versa. It can also be used following multi-pass rendering to combine the various render passes in different ways to control the look of a scene.

Compression
A technique for reducing the quantity of data required to make up a digital image. Compression techniques can be non-destructive ('lossless') or destructive ('lossy'), in which part of the data set is discarded permanently. Converting still images into JPEG format is one example of lossy compression.

Constrain
To restrict the motion of an object to one or two planes, or to a certain range of values within a plane, in order to simplify the process of animation. Constraints are commonly imposed on joints within a skeleton during the process of rigging a character for animation, in order to prevent that character from performing actions that would be physically impossible.

Constructive Solid Geometry
A modelling technique that combines simple solid forms, or primitives, into more complex models, by means of Boolean operations. Common primitives include the plane, the cube, the sphere, the cone and the torus.

Co-ordinate System
A set of numerical values used to denote a location in 3D space. In the Cartesian co-ordinate system, three orthogonal 'world axes' (the X, Y and Z axes) are used to define the position of a point relative to the intersection of these axes, or origin. Other co-ordinate systems can be used for modelling and texture projection.

CV
Control Vertex. A control point used to manipulate the shape of a NURBS curve.

Deformer
Usually: a modelling tool which deforms the structure of an entire object. However, the exact meaning of the term varies from software package to software package.

Dirt map See: Grime Map

Displacement Map
A recent advance on Bump Mapping. Like a Bump Map, a Displacement Map is a black-and-white image that a 3D software package projects over the surface of a model to generate surface detail. Unlike a bump map, however, a Displacement Map modifies the actual underlying geometry and is not merely a rendering effect.

DoF
Depth of Field. The depth of field of a specific lens is the range of acceptable focus in front of and behind the primary focus setting. It is a function not only of the specific lens used but also of the distance from the lens to the primary focal plane, and of the chosen aperture. Larger apertures will narrow the depth of field; smaller apertures will increase it.

Environment Map
An image intended to entirely enclose a scene, either to provide a convincing background, or to project real-world lighting or reflection data onto the surface of an object.

Expression
A mathematical formula used to define the value of a given attribute of an object during animation. The use of expressions forms a procedural alternative to hand, or keyframe, animation.

Extrusion
A modelling technique in which a two-dimensional outline or profile is duplicated outwards along a linear path, and the set of duplicated profiles joined to create a continuous three-dimensional surface.

Face
The front or back of an extruded object. The shape from which a 3D object has been extruded.

Fall-off
The way in which the intensity of a light diminishes with the distance from its source. In the real world, the fall-off of light is governed by the inverse square law, which states that the intensity is inversely proportional to the square of the distance. However, in 3D software packages, it is possible to use a variety of different mathematical formulae to describe the relationship.

F-Curve
Function Curve. An F-Curve is displayed in the Graph Editor of a 3D software package, and is used during the animation process both to display and to control the way in which a particular attribute of an object varies with time.

File Format
The format in which the data making up a particular 3D object or scene is stored. File formats come in two types: object formats, such as the LWO format in *LightWave* or 3DS format in *3ds max*, which contain only details of the geometry and surface properties of an object; and scene formats, such as their LWS and MAX equivalents, which contain such global information as lighting, animation or camera data.

Other file formats supported by most major 3D software packages include the DXF and IGES formats for CAD and NURBS models, the OBJ object format, and the cross-platform FBX format developed by Kaydara for the interchange of motion data between 3D applications.

Flythrough
A type of animation in which the camera moves around a scene, rather than objects moving in front of a stationary camera.

Forward Kinematics
Often abbreviated to FK, Forward Kinematics is a character animation technique for controlling the motion of the bones in a chain – for example, a limb – in which rotations propagate from bone to bone towards the free end of the chain (in the case of a limb, towards the hand or foot).

Frame
A still two-dimensional image. In computer animation, the term 'frames per second' (fps) is a measurement of the number of still frames displayed in one second to give the impression of a moving image. For film work, this value is usually 24; for the European PAL broadcast format, 25; and for the US NTSC broadcast format, 30 fps.

F-Stop See: Aperture

Global Illumination
A superset of the radiosity and raytracing rendering techniques. The goal of Global Illumination rendering is to compute all of the possible light interactions between surfaces in a given scene, and thus obtain a truly photorealistic image. All combinations of diffuse and specular reflections and transmissions must be accounted for. Effects such as colour bleeding and caustics must also be included in a global illumination simulation.

Graph Editor
The part of the GUI of a 3D software package where a particular attribute of an object changes over time is displayed graphically, in the form of an F-Curve.

Grime Map
Also known as 'dirt maps', grime maps are two-dimensional images applied to a particular channel of a material. When the image is projected across the surface of an object, it breaks up that channel's flat, even value, creating realistic surface variations.

Group
A set of sub-objects within a model or scene that move and behave as a single entity, yet can still be split apart (ungrouped), if necessary. Most complicated models are constructed from several less complex parts that need to maintain the same spacing and orientation; grouping provides a way of locking the relative positions of the objects without joining them permanently.

GUI
Graphical User Interface. An icon-based interface that controls a 3D software package. Although the GUI varies from program to program, there are certain basic conventions governing the layout of the main professional 3D applications.

Hard-Body Dynamics
Also known as rigid-body dynamics, hard-body dynamics simulate the physical behaviour of rigid objects that do not deform upon collision.

Hardware Rendering
Also known as display rendering, hardware rendering previews a 3D scene within the viewports on a 3D software package, providing real-time on-screen feedback about the effects of changes made to that scene, but omitting certain processor-intensive effects such as volumetrics, shadowing and realistic refraction.

HDRI
High Dynamic Range Image. A 2D image stored in a file format with a greater range of luminance values than a standard bitmap image. HDR images are often used as environment maps in image-based lighting techniques to create subtle, real-world lighting effects.

Hierarchy
The relationship of the sub-objects within a model or a scene to one another. Sub-objects may exist as parents, children or independents. A parent object controls the motion of all child objects linked to it, although the motion of a child object does not affect that of the parent.

History
A record of the previous values of the attributes of a 3D scene, enabling an artist to revert immediately to a particular earlier state. The history is especially valuable during the modelling process.

Hull
A series of straight lines connecting the CVs of a NURBS surface.

Image-Based Lighting
A technique in which a photographic reference image is used as an environment map to control the surface illumination of a 3D object, in order to create subtle real-world lighting effects.

In-betweening
The generation of intermediate transition positions between two keyframes. The term is drawn from traditional cel animation, where a lead artist generates the beginning and end keyframes of a sequence (typically one second apart), a breakdown artist does the breakdowns (typically four frames apart), and an 'in-betweener' completes the rest.

Interpolation
The mathematical procedure by which a 3D software package calculates the in-between positions between two keyframes.

Inverse Kinematics
Often abbreviated to IK, Inverse Kinematics is a character animation technique in which the end bone of a chain - for example, a limb - is assigned a goal object. When the goal object moves, the bone moves with it, dragging the rest of the chain behind it. The movement propagates from the free end of the chain towards the fixed point: the reverse of Forward Kinematics.

Isoparm
Lines on a NURBS surface connecting points of constant U or V co-ordinate values, and representing cross-sections of the NURBS surface in the U or V directions.

Joints
Points of articulation between the bones in a character rig.

Keyframe
An image, or set of attributes for a 3D scene, used as a reference point in animation. The artist usually sets up keyframes manually at significant points in the action, and the computer calculates the inbetween values automatically.

Lathing
A modelling technique in which a two-dimensional profile is duplicated in rotation around a reference axis, and the duplicates joined up to create a continuous three-dimensional surface. Lathing is particularly useful for creating objects with rotational axes of symmetry, such as plates, glasses, vases or wheels.

Layer
A level of an image that can be edited independently of the rest of the image.

Lens
In a real camera, a lens is a curved piece of glass or other transparent material that focuses light onto the film. Modern 3D software is capable of simulating a variety of optical distortions created by imperfections in real-world lenses, adding realism to the rendered output.

Lens Flare
A bright pattern on an image caused by the reflection and refraction of light within a camera. Although lens flares are actually artefacts of the photographic process, many 3D software packages offer artists the opportunity to add them deliberately in order to increase the realism of rendered output.

Light
A point or volume that emits light onto a 3D object. Types of light supported within 3D packages include Point lights, which emit light in all directions from a single point; Spot lights, which emit light in a cone; Distant or Directional lights, which emit light rays in parallel, illuminating all surfaces within a scene; and Area lights, which emit light from two-dimensional surfaces.

Lip Synching
The process of matching a character's facial movements to a spoken soundtrack during facial animation.

Lofting
A modelling technique in which a continuous three-dimensional surface is created by selecting and joining multiple two-dimensional cross sections or profiles.

Look Development
The process of developing the look of a 3D scene by compositing separate render passes together in different permutations.

Low-Poly Modelling
The process of creating simplified models with low polygon counts, usually for use in videogames, where scenes must be rendered in real time, by software with a limited ability to handle complex models.

Match-moving
See: Camera Tracking.

Material
A set of mathematical attributes that determine the ways in which the surface of a model to which they are applied reacts to light. These attributes are sub-divided into individual channels.

Mask
An area that can be protected and isolated from changes applied to the rest of the image.

Mesh
The surface geometry of a 3D model, made up of a series of linked geometry elements such as polygons, patches or NURBS surfaces.

Metaball modelling
A technique in which models are created using spheres (or, more rarely, other primitive objects) that attract and cling to each other according to their proximity to one another and their field of influence. Metaball modelling is particularly useful for creating organic objects.

Model
Used as a verb, to model means to build a 3D object. Used as a noun, it

Without lights, the objects in a 3D scene will not display on rendering. The terminology of CG lighting, and the techniques it employs, are similar to that of real-world cinematography

PICTURES: Simon Danaher

means the 3D object created as the end product of the modelling process. A variety of different methods are used in 3D modelling, including polygonal, NURBS, Sub-D and metaball techniques.

Modifier See: Deformer.

Morph
To transform from one state to another. Morphing is commonly used in lip-synching, in order to transform the head model of a character between a variety of preset states (or 'morph targets'), corresponding to common facial expressions, in order to create the illusion of speech.

Motion Blur
An artefact of real-world cinematography in which the camera's target object is moving too quickly for the camera to record accurately, and therefore appears blurred. Many 3D software packages simulate motion blur as a rendering effect, in order to increase the realism of 3D images or animation.

Motion capture
Often abbreviated to mo-cap, motion capture is the process of recording the movements of a live actor, and converting them to a 3D data format which can then be applied to a virtual character.

Multi-pass rendering
To render out the lighting or surface attributes of a scene as separate images, with a view to compositing

them together later. Multi-pass rendering can be used simply to speed up the rendering process, or in order to develop the look of a scene by compositing the different passes together in various permutations.

Negative Light
A light within a 3D scene that decreases the illumination on a surface instead of adding to it. Negative lights can be used to remove 'overspill' in brightly lit scenes.

Normal
An imaginary line drawn from the centre of a polygon (or other geometry object) at right angles to the surface.

Null
A point within a 3D scene that does not render out, but which is used as a reference for other objects.

NURBS
Non-Uniform Rational B-Splines. NURBS curves are two-dimensional curves whose shape is determined by a series of control points or CVs between which they pass. When a series of such curves are joined together, they form a three-dimensional NURBS surface. Such surfaces have a separate co-ordinate space (known as UV co-ordinate space) to that of the 3D scene in which they are situated. NURBS are commonly used to model organic curved-surface objects.

Object
A generic term describing any item that can be inserted into and   >>

manipulated within a 3D scene. Models, lights, particle emitters and cameras are all objects.

Object file See: File format.

Origin See: Co-ordinate System, Axis.

## Parent See: Hierarchy.

Patch
An area of a NURBS surface enclosed by a span square: the shape created by the intersection of four isoparms, two in the U direction, and two in the V direction.

Particle System
An animation system consisting of a large number of very small points whose behaviour is determined mathematically. A particle system typically consists of an emitter (which may be a point, surface or volume, and may emit particles directionally or in all directions) and a series of fields that determine the motion of those particles. Individual particles have a finite lifespan, and may possess attributes (such as colour, radius, and opacity) that vary over the course of that lifespan. Particle effects are commonly used to simulate fire, smoke, steam and other fluids, or to control complex animations such as crowd scenes.

Phong See: Shading.
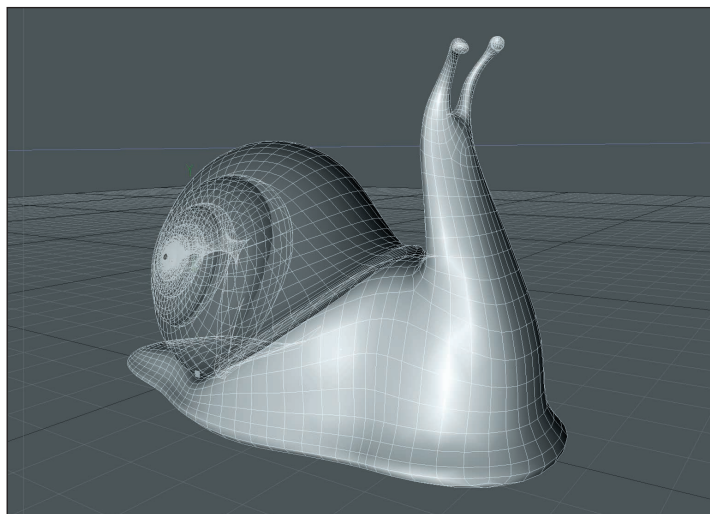
A 3D model, displayed here in wireframe format. Models are one of the basic building blocks of 3D scenes, and may be created using a wide variety of modelling techniques

Photogrammetry
Also known as image-based modelling, photogrammetry is the process of generating a fully textured 3D model from a series of photographs of a real object. Although it was once an expensive high-end technique, there is now a range of increasingly inexpensive photogrammetry software packages on the market.

Plane
A two-dimensional surface in Cartesian co-ordinate space. Essentially a flat sheet extending infinitely in all directions, a plane may be used to aid object manipulation, positioning and construction, and is not usually made visible in a final render.

Plugin
A small piece of third-party software that is loaded into a 3D application in order to extend its functionality. Plugins commonly perform such specialist tasks as file conversion or data export, texture generation, and physics or fluid simulation. There are thousands of plugins currently available on the Internet, both commercially and as free downloads.

Point
A one-dimensional point in co-ordinate space. Points can be linked up to form polygons, used as control vertices for NURBS curves, or employed as nulls to control lights or cameras, amongst other functions.

Polygon
A geometry element formed by connecting three or more points. A triangle, or three-point polygon, is the simplest form of polygonal geometry. Polygonal modelling is a fast, intuitive method of creating 3D objects, but does not easily generate smooth curved surfaces.

Post Processing
The manipulation of a rendered image, either to improve the quality of that image, or to create effects that cannot easily be achieved directly within the 3D software itself. Some 3D software packages can be set to automatically apply post-processing effects, such as motion blur or Depth of Field, after a frame is rendered.

Preset
A pre-generated list of settings for a particular 3D software package. Presets are usually used to control and customise properties such as rendering or lighting styles. Like plugins, they may either be commercial products, or freely downloadable from the Internet.

Preview
A time-saving method of checking the progress of a project by rendering it at a lower quality, resolution or frame rate than will be used for the final project.

Primitive
A simple three-dimensional form used as the basis for constructive solid geometry modelling techniques. Typical primitives include the plane, the cube, the sphere, the cone and the torus.

Procedural Texture
A texture map that is generated by a mathematical function, rather than a real-world bitmap image projected over the surface of an object.

Projection
The process by which a two-dimensional texture map is applied over the surface of a three-dimensional object, as if it were an image projected from a slide projector. There are several common projection types, including Planar, Cubic, Spherical and Cylindrical. Which one is most appropriate depends on the type of map being projected, and the shape of the object it is being projected upon.

Quad view
A method of displaying 3D scenes adopted by many high-end software applications, in which a scene is shown simultaneously in Top, Side, Front and Perspective views.

Radiosity
A technique for rendering 3D scenes. Radiosity simulates the way in which light bounces from surface to surface within a scene, and is more accurate, but also more processor-intensive, than raytracing.

Raytracing
A technique for rendering 3D scenes. Raytracing traces the path of every ray of light from its source until it either leaves the scene or becomes too weak to have an effect. The term is also sometimes applied to the reverse method: tracing the path of every ray of light from the camera backwards to the light source.

Reflection Map
An environment map used to simulate real-world reflection effects on the surface of a 3D object. Reflection maps render more quickly than methods that generate true surface reflections, such as raytracing.

Rendering
The process of converting the 3D data stored in a software package into the two-dimensional image 'seen' by the camera within the scene. Rendering brings together the scene geometry, Z-depth, surface properties, lighting set-up and rendering method to create a finished frame. Rendering comes in two forms: Display or Hardware rendering, used to display the scene on-screen in the software package's viewports; and the more processor-intensive Final-quality or Software rendering, which generates an image for output, and takes account of properties that Display rendering

overlooks, such as shadows, reflections and post-process effects.

Resolution
The size of the final image in pixels when rendering out a scene. Higher-resolution renders contain more detail, but take longer to complete.

Rigging
The process of preparing a character model for animation, including setting up an underlying skeleton, complete with constraints, controllers and kinematic systems, and linking it to the mesh of the character model.

Scene
A set of 3D objects, including the models themselves and the lights and camera that will be used when rendering them out.

Scene file See: File format.

Script
A small piece of code created in a 3D software package's own internal programming language, and used to automate common or complex tasks.

Shading
The mathematical process of calculating how a model's surfaces react to light. A variety of alternative algorithms can be used for the task, including Phong, Lambert, and Blinn shading models. Shaders are often built up as node-based shading trees, with each node controlling a specific aspect of the process.

Skinning
The process of binding the surface of a model to the underlying skeleton during character rigging.

Skeleton
An underlying network of bones used to define and control the motion of a model during character animation. Moving a bone causes the mesh of the model to move and deform.

Snapping
The automatic alignment of one object to another or to a reference grid, intended to aid the precise placement of objects within a scene or modelling hierarchy.

Soft-Body Dynamics
The simulation of the behaviour of soft bodies that deform on collision with other objects, such as cloth or fluid flows.

Specularity
A surface property of an object that determines the way in which highlights appear on that surface.

Spline See: NURBS.

Subdivision Surface
Also known as Sub-Ds, subdivision surfaces are surfaces created using a technique midway between polygon and NURBS modelling. They consist of an underlying polygonal base mesh, which is automatically subdivided by the software to create a smoothed final form. Sub-Ds combine much of the power of NURBS surfaces with the intuitive characteristics and ease of use of polygonal modelling tools.

Sweep
A modelling technique similar to extrusion in which a two-dimensional profile is replicated along a path, then joined to form a continuous three-dimensional surface. Unlike extrusion, however, this path need not be perpendicular to the profile. By sweeping a circular profile along a helical path, for example, it would be possible to model a coiled cable of the type commonly found on telephones.

Symmetry
A modelling option in which any changes made to the model are duplicated across an axis of reflectional symmetry. This makes it possible to create complex symmetrical objects, such as a human or animal head, without having to work directly on more than one half of the model.

Texture
A bitmap image that is applied to the surface of 3D object to give it detail. Texture maps may be either photographic images or procedural textures, and may be applied in each of the material channels of an object using a variety of mapping or projection methods.

Three-Point Lighting
A system of CG lighting derived from real-world cinematography, in which a scene is illuminated by three light sources: a Key light, which acts as the primary source of illumination for the scene; a Fill light, which illuminates shadow areas; and a Rim light, which illuminates the edges of objects and helps them stand out from the background.

Tiling
The process of duplicating a texture across the surface of an object. Tiling textures must be created so that the edge of one aligns perfectly with that of its neighbour, otherwise the result is a series of ugly seams. High-frequency textures are those in which patterns repeat at short intervals over an object's surface; low-frequency textures are those in which the intervals are larger.

Timeline
A fundamental element of the graphical user interface of most modern 3D software packages which shows the timing of the keyframes in a sequence of animation. Playback of the animation may be controlled either by a series of VCR-like controls, or by clicking and dragging with the mouse to 'scrub' a slider to and fro along the timeline.

Trimming
The process by which NURBS surfaces are edited. The trimming tools allow 3D artists to define areas on a NURBS surface that will be made invisible and not render out, even though their CVs still exist. Separate trimmed surfaces may be joined together by using a variety of techniques, including Attaching, Aligning, Filleting and Stitching.

UV Texture Co-ordinates
The co-ordinate system used for assigning textures to polygonal models. Since UV co-ordinate space is two-dimensional, one of several projection methods must be used to 'unwrap' the UVs from the model and lay them flat on a plane. Once unwrapped, the UV map may be screengrabbed and exported to a paint package for texture painting.

Vertex See: Point.

Viewport
The region of the interface of a 3D software package in which the scene is displayed to the artist.

Volumetrics
Volumetric lights are lights whose illumination can be observed throughout a volume of space, rather than simply where the light strikes a surface. In similar fashion, volumetric textures are textures applied throughout a volume of space, rather than to a surface.

Walk Cycle
A short sequence of animation containing the keyframes necessary to make a bipedal character take two consecutive steps. The sequence may then be repeated over and over again to animate the character walking forward. Walk cycles may be modified in many subtle ways to suggest information about a character's age, gender, emotional state or personality.

Weighting
The process of determining which bone in a skeleton affects which part of a model's surface mesh. In many cases, this is achieved by painting weight maps onto the surface of the model that delineate a particular bone's area of influence.

Wireframe
A shading method in which a simple grid of lines is used to represent the basic contours of the underlying model. For many 3D artists, this is a favoured mode to work in, since it permits them to see faces and surfaces that would otherwise be hidden by overlying geometry.

World axes
See: Co-ordinate systems.

Z-depth
The distance a particular point or surface lies inside a scene. Z-depth information is used to calculate where a light casts shadows, and also to calculate which surfaces are visible to the camera during rendering, and which are obscured by nearer geometry. ■