BACKGROUND

The commonest approach to 3D modelling is to start with a basic 3D shape, then modify it to create the final shape. Next, we add one or more materials to our shape to give it colour, shine and transparency as required. A texture image can be assigned to a material to give the shape the appearance of being constructed from some medium such as wood, stone or brick. Finally, our scene is processed by a render engine which creates a final, realistic image.

Of course, this is a greatly simplified view of the stages required and where we want to create an animated sequence rather than a still image there are many more steps required in the process.

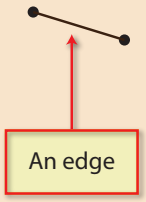
In this section we'll have a brief look at the main concepts that are involved in producing static 3D models.

This background knowledge will give us a good foundation for the remaining sections of the book where we will learn in detail how to create our models using Blender - a free 3D modelling package.

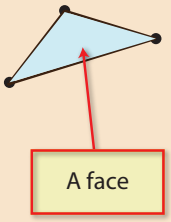
3D Modelling Basics

The fundamental building block of most 3D models is the **vertex** – a single point in space.

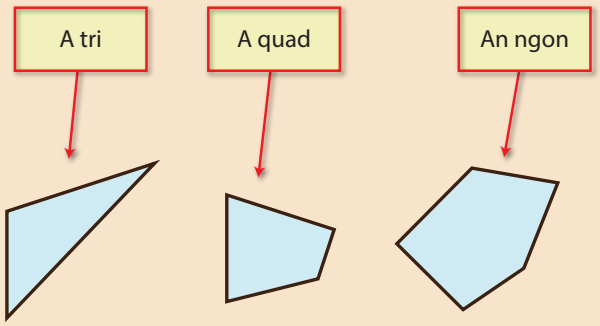
Two vertices can be joined together by an **edge**.



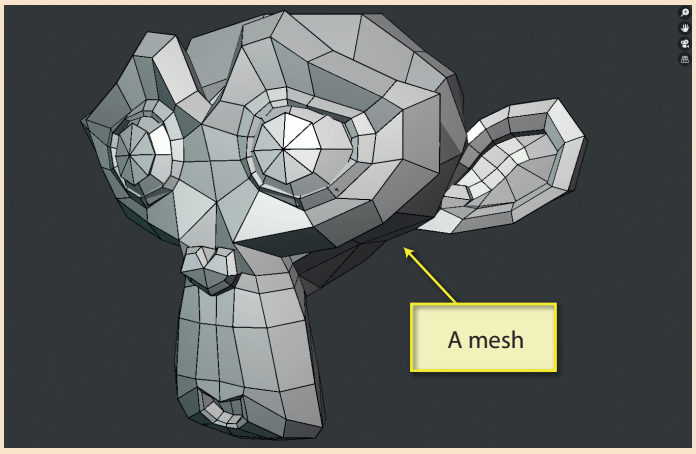
Three or more edges can be joined to create a **face**.



In Blender, a face with three edges is known as a **tri** (as in triangle); one with four edges is called a **quad** (as in quadrilateral); and a face with more than four edges is termed an **ngon** (short for *n*-sided polygon and sometimes written as ***n-gon***).

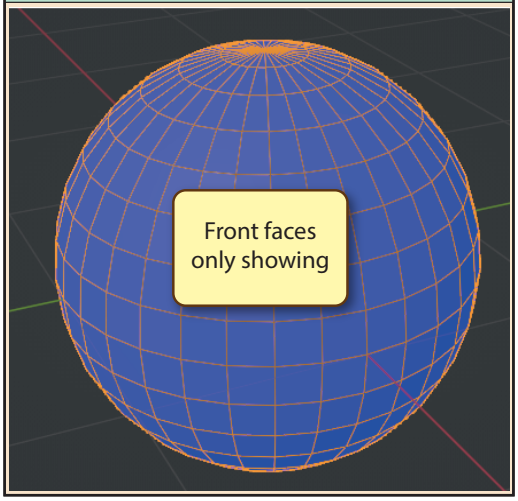


By combining a set of faces into a group (known as a **mesh**), we can create a 3D shape. Note that a vertex may be shared by more than one edge and that an edge may be shared by more than one face.

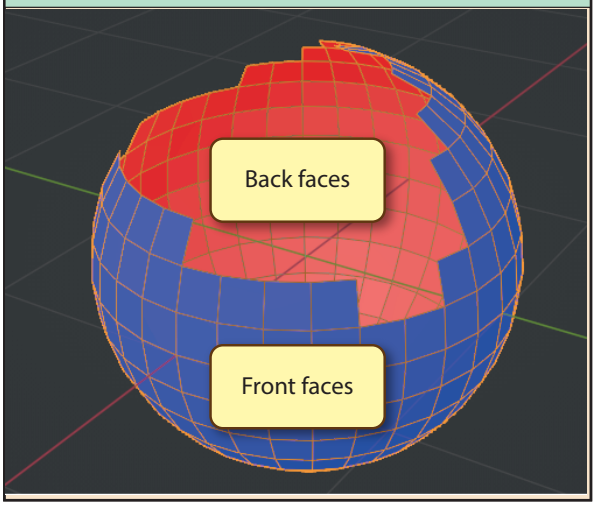


Like a coin, every face has two sides: one side is designed to be seen by the viewer (known as the **front face** or just **face**) and the other side hidden (the **back face**).

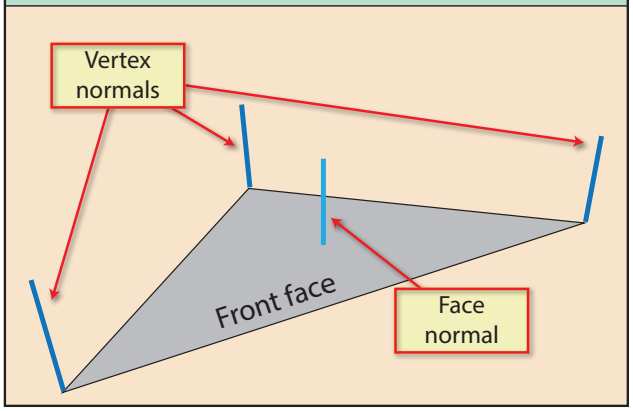
If we have a sphere-like mesh, then all we can see are the **front faces** of the object (shown below in blue).



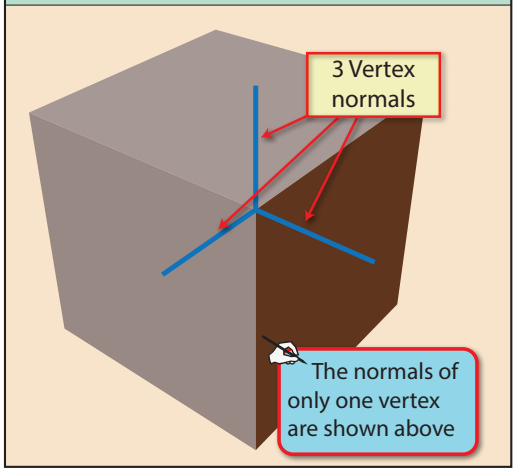
However, if we remove part of the sphere, some **back faces** are exposed (shown in red).



Another feature of every face is a set of **normals**. Normals may be thought of as invisible lines radiating from the front face (**face normals**) and every vertex (**vertex normals**). Face normals are always perpendicular to their associated face and vertex normals are perpendicular to the two edges that meet there.

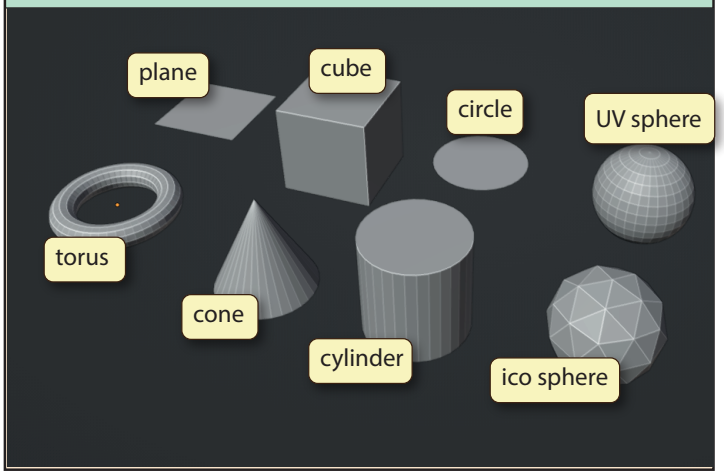


Where more than one face shares a vertex, a vertex normal is created for each pair of edges.

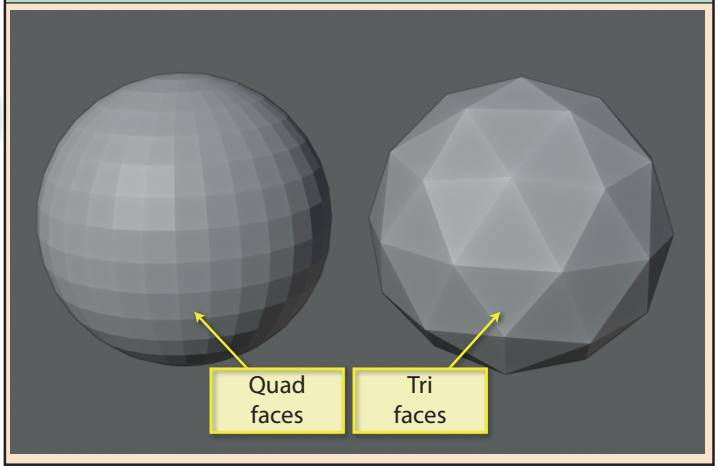


Blender uses normals, not only to determine which side of a face is the front face, but also to calculate shadows and reflections.

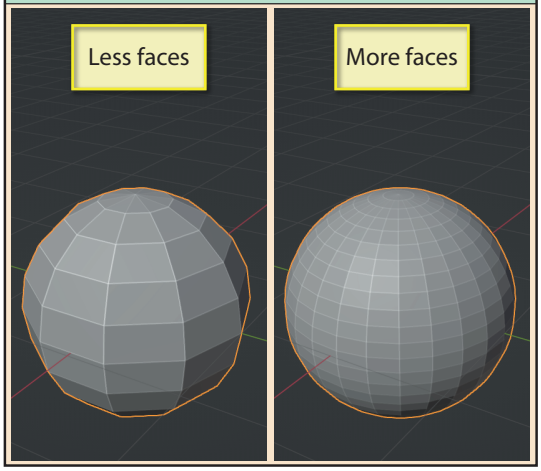
Generally, models are created by joining and/or modifying meshes. Most modelling packages offer a set of basic shapes which can be created automatically. These are known as **mesh primitives**. The commonest primitives offered by Blender are shown below.



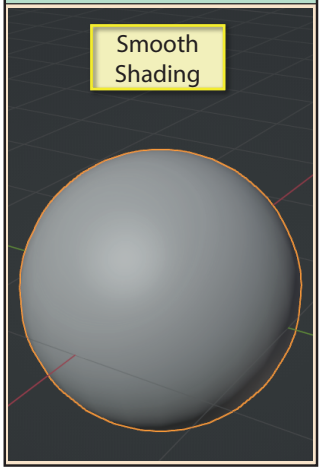
Notice that the ico sphere has **tri** faces while the UV sphere has (mostly) **quad** faces. ***Quads*** are considered the most desirable shape for faces when modelling.



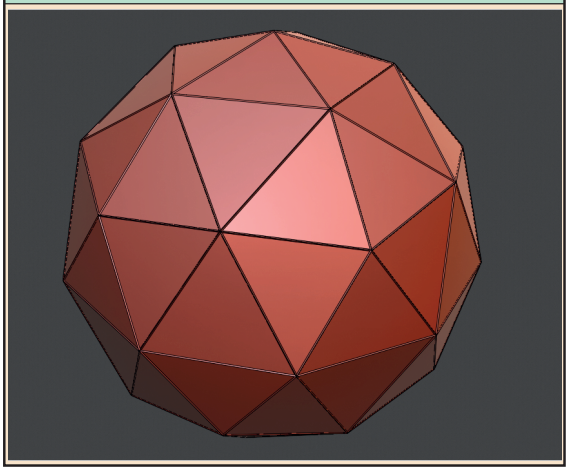
For curved shapes, the more faces a mesh contains the more realistic the model will appear. The number of polygons in a model is usually referred to as the **polycount**.



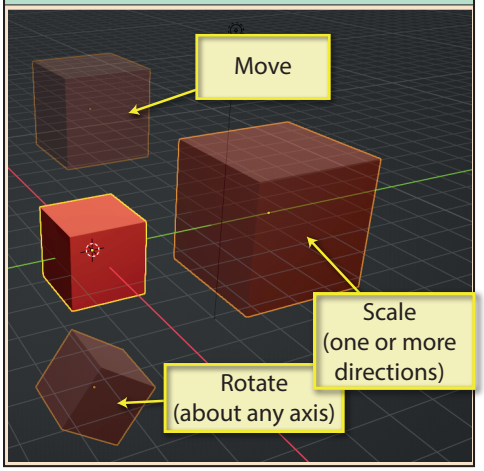
An even more effective way of creating the illusion of a curved surface is to adjust the shading.



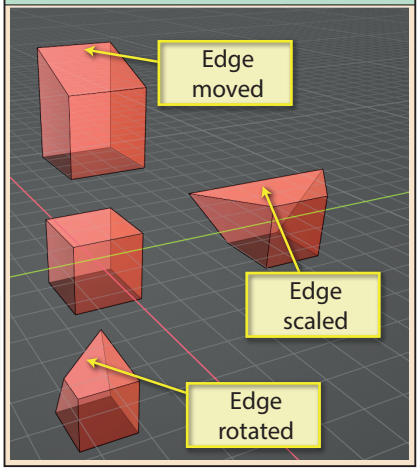
While modelling, we can assign a temporary colour to the objects in our scene. This colour has no effect on the final result but may help make objects easier to see during the modelling process.



When creating our scene we can move, rotate or scale a complete mesh...

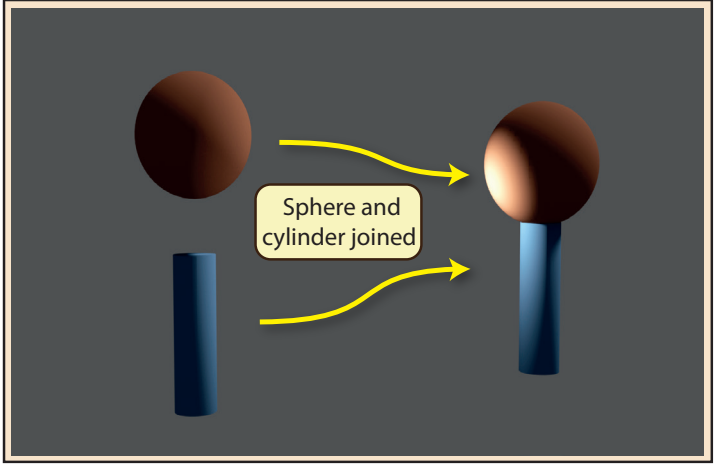


... or we can move, rotate or scale parts of the mesh.

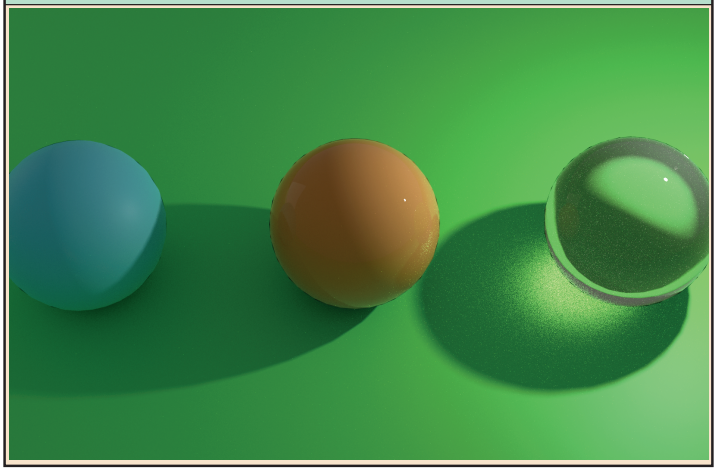


When creating organic shapes such as people or animals many modellers use sculpting. This technique is somewhat similar to molding clay and requires a fair degree of artistic talent!

Another option is to join two or more primitives to create a new shape.



Adding a **material** to an object allows us to define that object's final characteristics such as colour, reflectivity and transparency. For example, a material can give an object a dull or shiny finish or have it appear to be made of glass.



Once an object has been assigned a material it can also be given a **texture**. A texture normally consists of one or more images.

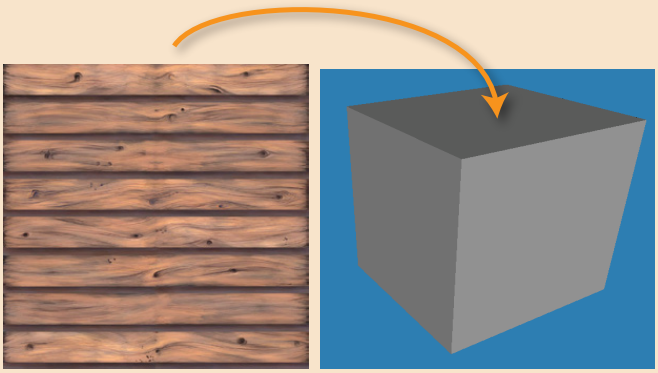
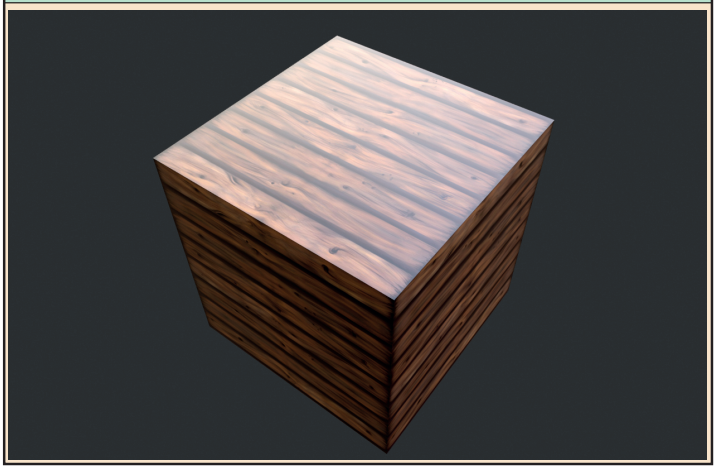


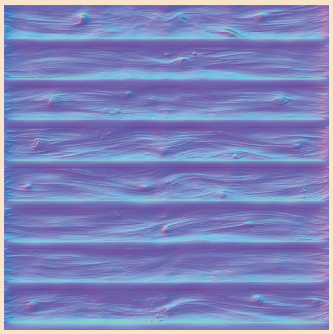
Image Object

This adds a texture to the object giving the impression that the object is constructed from the material shown in the image.



To add further realism to an object we can assign a **normal map image** to the object...

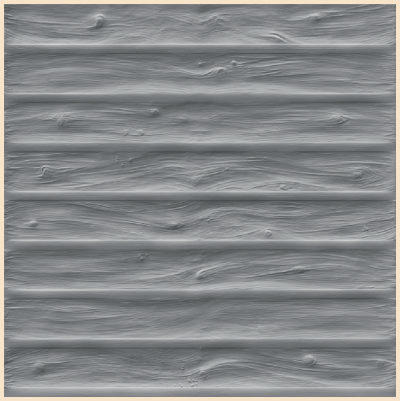
Texture Image



Normal Map Image

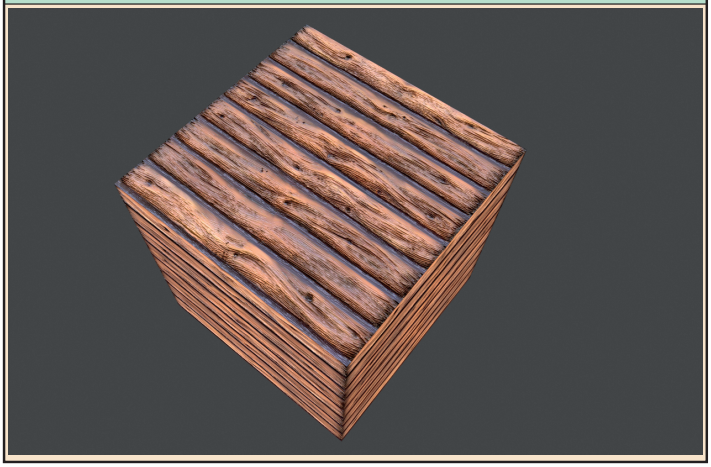
By adding the normal map image, the object appears to have a rougher, pitted surface (depending on the nature of the new image) without actually adding more faces to the object itself.

By adding a **displacement map image** to the object...

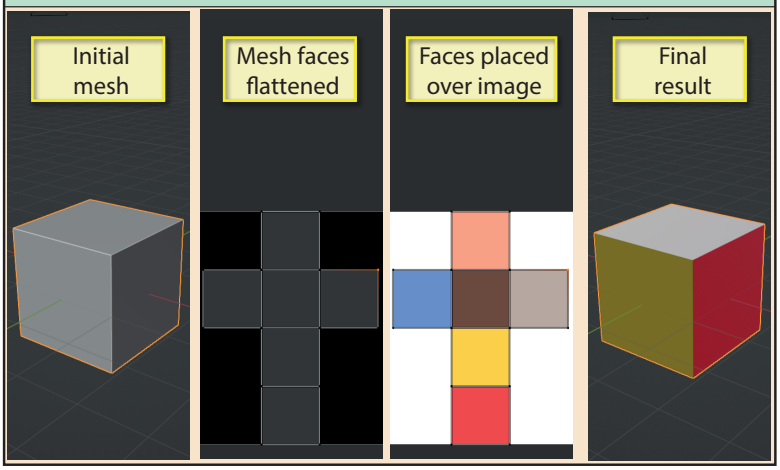


Displacement Map Image

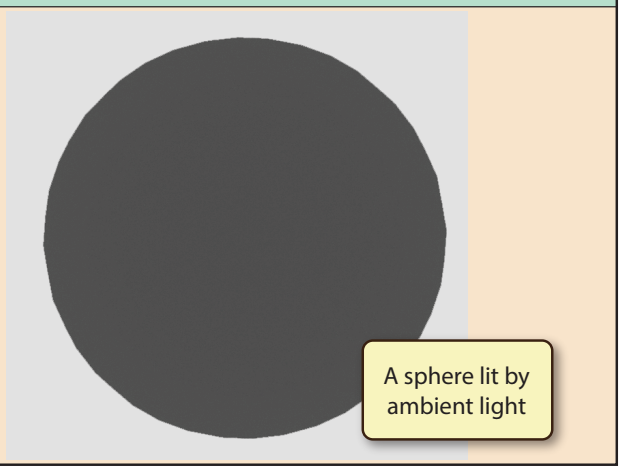
...we can increase the number of faces in the model and create genuine lumps and bumps on the surface.



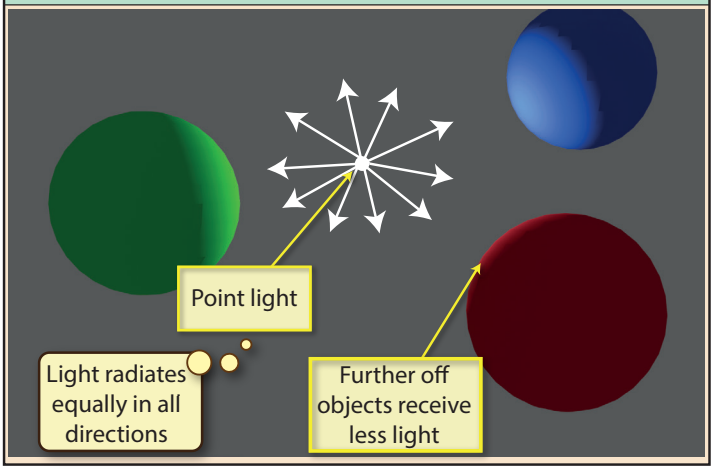
By laying out the faces of an object's mesh so that we create a flat shape, we can control which part of the texture image appears on each face (this is called **UV mapping**).



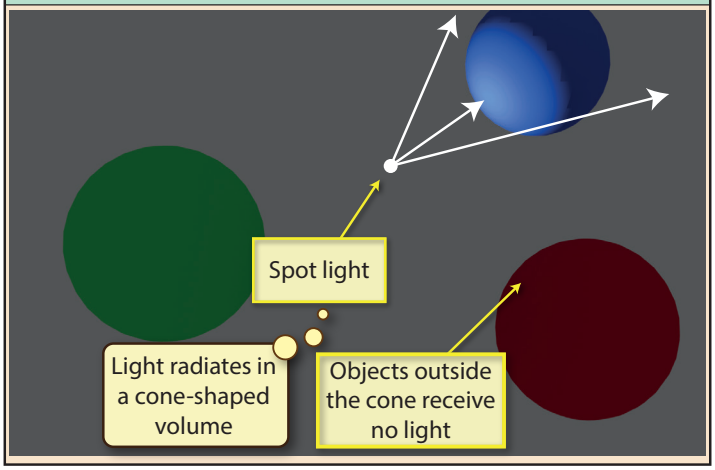
Objects in a scene are only visible because they reflect light. The most basic light is an **ambient light** in which light comes equally from all directions. This creates a flat light without shadows or highlights.



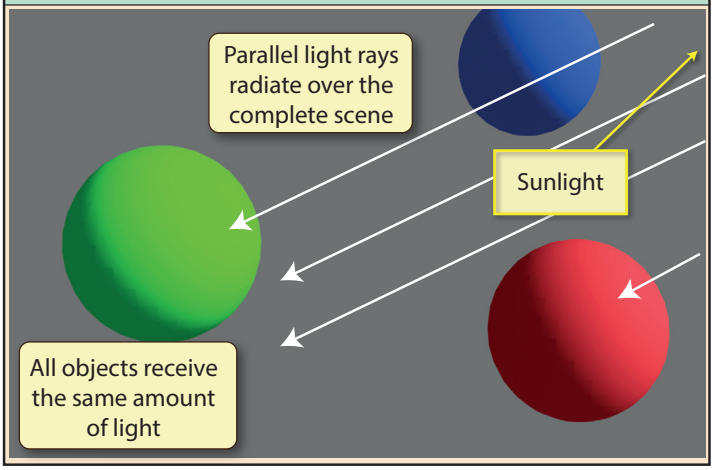
A **point light** emits light in all directions from a single point in space with the light cast on an object becoming weaker the further the object is from the light.



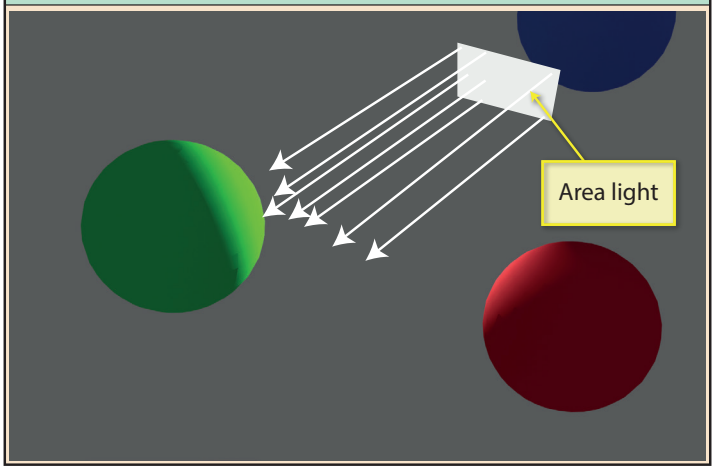
A **spot light** casts light within a cone-shaped volume (think of search light scanning the skies). Like a point light, objects at a distance receive less light.



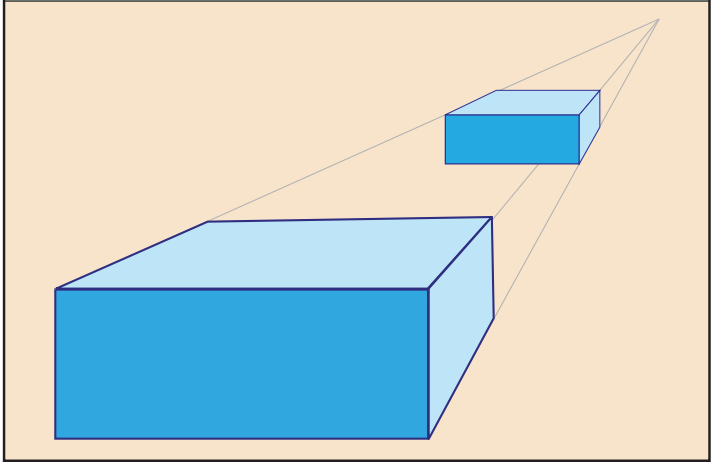
Sunlight (also called **directional light**) casts a set of parallel light rays with all objects receiving the same intensity of light. Positioning of the light is irrelevant. The angle of the light rays can be set.



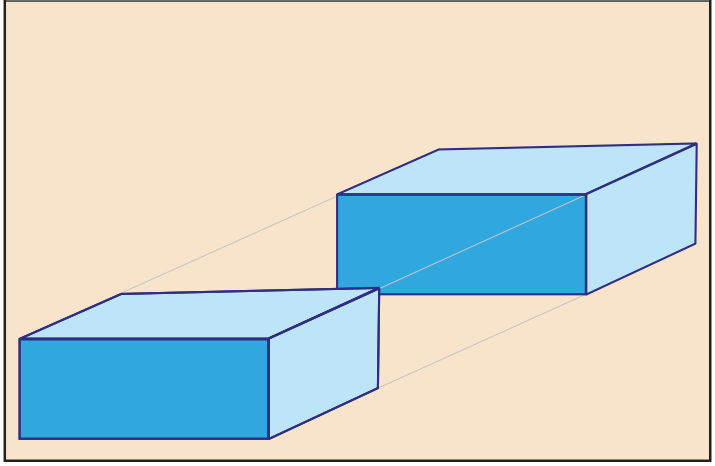
Area light simulates a light originating from a flat area such as a panel light found on a ceiling. This is a form of directional lighting.



When creating a model, we have the option to work in **perspective viewing mode** (where objects appear smaller the further away they are and real-world parallel lines converge to a single point.



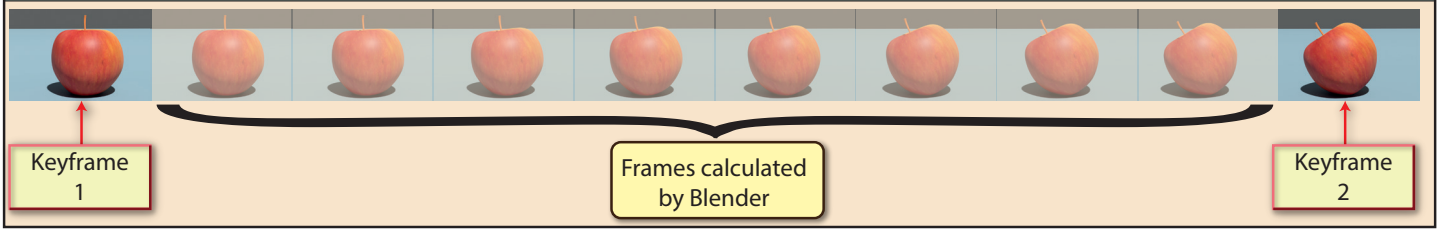
However, it is often more accurate to work in **orthographic viewing mode** where real-world parallel lines remain parallel and objects don't get smaller in the distance.



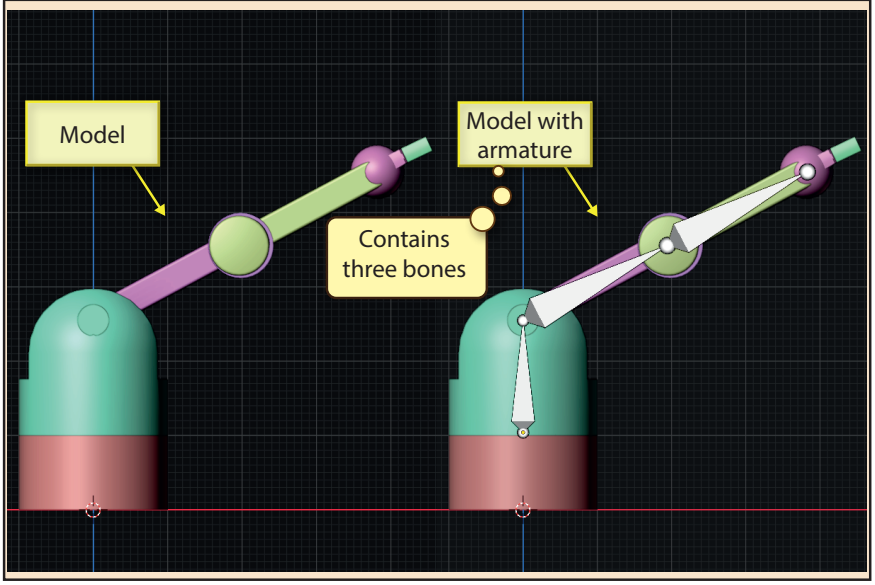
The final part of the process when creating a photographic-quality image or video animation is to **render** the model. ***Rendering*** - which is performed by a **render engine** - creates a detailed image which includes textures, shadows and reflections. The highest quality renders may take minutes or even hours depending on the processing power of the computer being used.

If, rather than creating a single, static image, we wish to create an animation, then we must create a set of frames, each with a slightly different image. These frames, when played in rapid succession, these create our animation.

Luckily, we don't have to create each of these frames manually. Instead we create only the important frames (known as **keyframes**) and Blender automatically creates the intermediate frames.



When our animation involves reshaping meshes, then we normally add an **armature** (also known as a **rig** or **skeleton**). An ***armature*** is a set of bones and joints. Each bone is associated with some part of the mesh.



When the bones are moved, the linked part of the mesh also moves. We can now add keyframes by adjusting the bone positions and Blender will create the intermediate frames with the final animation saved as either a set of still images or as a video file.