

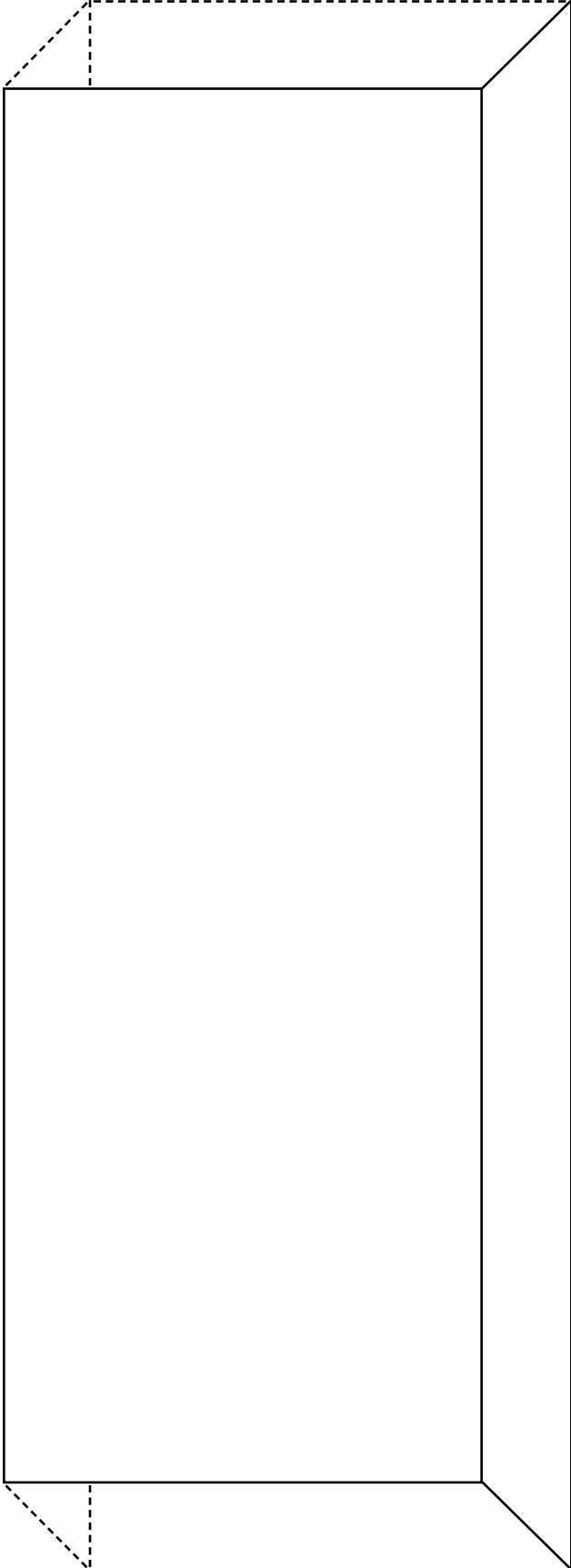
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# 3D Fundamentals - 101

Introduction to 3D





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## Welcome to the Universe of 3D!

The fantastic universe of 3D animation is a remarkable and growing industry. It's doubtful that anyone back in the "old days" would have imagined that 3D graphics and animation would come so far since the motion picture Tron from Disney was released. Tron was the first motion picture in which 3D animation was used. Today, we are all used to seeing animated aliens or dinosaurs being brought back to life with frightening detail for our amusement. Even car commercials on television fool us, for most of those cars aren't even real. They merely exist as a vast number of points and polygons in the memory of a computer system.

This however, should not lead to the belief that computers are entirely responsible for creating these magnificent works of art. Quite the opposite in fact! The need for a talented individual is a must. To be successful in this industry takes, first and foremost, a very creative imagination. Computers most certainly lack that, as they cannot think for themselves, well... the ones we're dealing with! There are also numerous 3D software packages available on the market to choose from. In some cases one particular package may not be able to do the job on its own. Therefore, one needs to have the ability to use and manipulate the software well enough to not only be productive, but to be able to convey their imagination to the screen and bring it to life.

Of course, that is not all. The majority of tasks someone may be required to do is most likely at the direction of a client or project manager. Hence, the ability to communicate properly with co-workers is at the utmost importance. Patience is also a very valuable asset. Animation and graphics aren't usually something that can be put together in a matter of moments. 3D is one of the most complex and unique industries in the multimedia genre, and stands proudly on its own. One should consider themselves very fortunate to be working in a field such as this.

## Necessities

In the past, the average desktop computer could not handle high-end 3D graphics and animation very well. Things have greatly changed however. With the vast majority of PC's and Mac's available, professional quality graphics can be produced. In the next few sections we'll discuss what to look for when one is in the

market of purchasing a computer system. Obvious equipment includes the major hardware components such as the CPU (Central Processing Unit), video card, monitor, operating system and software. Platform considerations must also be taken into account. A Silicon Graphics Workstation can cost considerable more than a PC. But as with most devices, there advantages and disadvantages.

Let it also be clear that cost is not the only determining factor when purchasing a computer system. Most users would probably select the least expensive machine to save money for other life worthy expenses, and as a general purpose word processor and gaming system that's fine. But when it comes to an important deadline to meet with a 3D project, it's most important that one can trust their computer system to quickly process whatever information the user requires. Now true, one should not spend their life savings on a single computer, but serious consideration should be taken into account. The old saying, "You get what you pay for." is usually correct. Also, depending on the computer platform purchased, certain peices of hardware and software may not be available or could cost substantially more.

## Platform Considerations

We have chosen to discuss what would probably be considered as the top 3 platforms to develop animation and graphics on. The PC, or IBM and compatibles, Apple brand computers, and Silicon Graphics workstations.

### PC Systems (IBM and compatibles)

<http://www.ibm.com/> - PC's are one of the most popular and accessible computer systems on the market today. There are computer stores around almost every corner selling these machines. The advantage to this is cost. The larger number of stores selling similar units, the greater the competition is. Although there tends to be a substantial difference in quality of service. It is up to the consumer to select a store with good service and price. Sometimes paying the least in this case is not the best option. It could lead to no-name brands being substituted for higher quality brand named equipment.

There's also a great number of options to choose from when getting a PC. We'll begin with the CPU. Intel and AMD are the 2



## Terminology to Know

**Rendering** - A process by which 3D software applies a skin to 3D geometry. This may also involve coloring or even texturing the object. This rendered image is then, in most cases, saved to the hard drive for further use.

**NTSC** - Stands for National Television Standards Committee. This is a standard for broadcasting television signals in primarily North America. For example, NTSC video runs at 29.97 frames per second (usually rounded up to 30 frames per second for shorter productions).

**PAL** - Stands for Phase Alternating Line. This is the European version of our NTSC. In comparison, PAL video runs at 25 frames per second and has a resolution of 720x576 lines.

## Fun Fact

IMAX's film resolution is the largest of any motion picture medium in practical use. It measures a whopping 4096x3072 (commonly referred to as 4K) pixels in size, and is usually 16bits / color channel (RGB). A single frame is approx. 72MB in size!

heavy hitters in the market for processor manufacturing. For animation and graphics, the most logical choice is to go with the fastest processor available. This ensures that the computer can keep up with the users actions, and that render times are low. Speeds of these CPU's have reached up to 1.7GHz (Intel's Pentium IV). Costs have also fallen to a point where they're more accessible to everyday users.

Memory is also a great issue with 3D, both temporary memory, RAM (Random Access Memory), and permanent storage, hard drives. With most 3D software these days, 128MB of RAM isn't a whole lot. If one is planning to purchase a system our recommendation is 256MB or more. Most 3D programs store object geometry and texture map data, the images on objects, backdrops, etc., in RAM. Now as for hard drive capacity usage, 3D models aren't that large. A very complex model may only be around 5 to 7MB. This size however, greatly depends on the software used. Higher end software tends to create smaller and more efficient files.

What does take up far more space, are the rendered images for the animation and texture maps. To create more realistic imagery, higher resolution textures need to be used. For best results these textures are also uncompressed files. Therefore, a single texture map can be anywhere from approx. 900KB for a 640x480 pixel sized image at 72 DPI, upwards to 12MB for a file around 2400x1800 pixels at 72 DPI. Now most popularly, animations are rendered out as still frames. The usual pixel size for a rendered image for video is 720x486 at 72 DPI and is 1MB in size. Now NTSC Video runs at 30 frames per second. If one was creating a 30 second fully animated piece, there would be a total of 900 frames. That would equal approx. 900MB of storage space needed to hold that animation (size of a single file multiplied by the total number of frames). An uncompressed video file would take up the same amount of space.

Video cards should also be taken into great consideration. Not only do most animators work on 19 inch or larger monitors, but 3D software usually requires some sort of graphics acceleration to display geometry and texture data on screen. The CPU, along with the many other calculations it must already complete, cannot handle the screen output very well. This leads to significant lags between the users interaction with the software. Video cards have their own hardware built in, like a GPU

(graphics processing unit) and even video RAM. A good overall video card should have a 4X AGP (advanced graphics processing) interface, at least 32MB of onboard memory, and have a chipset that supports whichever 3D software the user has installed. Some video cards may not have support for a particular piece of software and will not accelerate as one would think. For further information on this topic, a good idea would be to logon to the Internet and do some searching. PC magazine Web sites and hardware bench mark sites.

Finally we reach the operating system that makes the computer function. The vast majority of PC's use the Windows O/S from Microsoft. For 3D work, the usual recommendation is Windows NT or 2000. These operating systems are far more stable, more powerful and faster than the consumer aimed Windows 98 and ME. Also, most higher end 3D software will only work on either Windows NT or 2000.

## **Apple Computers**

<http://www.apple.com/> - Although Apple's computers sit as a minority against the IBM and compatibles arena, they are still very powerful and stable machines. Macintosh, Apple's product line of computers, can be purchased from either Apple's own dealerships, or from privately owned stores. Buying tends to be easier as you basically have a choice of one brand. Price wise, Macintosh computers tend to cost a bit more on average, although again this changes greatly due to the hardware selected with the machine.

Today's choice for creating 3D animation and graphics on the Macintosh is the G4 processor, produced by Motorola. They are a true 64 bit processor and speeds reach over the 800MHz mark. One may immediately believe that the PC, with a 1.7GHz processor is twice as fast. This is not correct, for a PC based or usually termed Intel based processor, is only 32 bits. Their speeds would approx. be equal. Think of it this way. The data pipeline for a G4 is twice the size of an Intel based processor. However, data through the G4's pipeline moves at half the speed of the Intel processor. They tend to both finish the race at almost the same time. Another consideration to take into account, is the G4's architecture is different from that of an Intel processor. It may do some computations faster, but on the down side, some may be far slower. There are some benchmarks available on the Internet

regarding various issues.

Now as for memory considerations for a Macintosh, pretty much the same goes. 3D software doesn't behave or really look that different on a Mac. So again the more RAM the better. And because there are standards in place for the video and film industry, when you render a frame on the Mac, it's basically the same as it would be on a PC. So for hard drive capacity expect something in the 40 to 60GB range. Different brands of video cards can also be purchased for the Mac. Again the same rules apply. The 3D software still behaves the same as it would on a PC.

With the release of O/S X (The tenth version operation system from Apple), many higher end 3D packages are now available for the Mac. O/S X is based on UNIX, a high end and more stable operating system that was primarily installed on computer systems like Silicon Graphics. Maya, Softimage, LightWave 3D and 3D Studio Max can now all run on this operating system. Some could run on earlier operating system versions, like LightWave 3D. The UNIX like environment adds far more power and stability to the Macintosh line of computers.

## **Silicon Graphics Workstations**

<http://www.sgi.com/> - One thing holds quite true for the Silicon Graphics Inc. company, they have a unique niche market. Their computer systems are probably one of the most powerful in production. They make entry level systems costing only a few thousand dollars, to super computers costing millions.

Businesses, or the fewer private owners, who use these machines usually create far more elaborate 3D animations and graphics. Take the motion picture industry as an example. The visual effects are stunning, not only in the design aspect, but also from the level of technical detail and complexity. There may be millions of particles simulated and rendered to create life like dust storms, or complex fluid dynamics used to calculate realistic oceans of water. PC and Mac systems would take far longer to generate such effects and frankly they lack in data bandwidth, greatly compared to some SGI workstations.

Another use for SGI's workstations turns away from the visual effects industry. Take for example military applications. Instead of detonating a nuclear bomb on the surface of the Earth to study it, they can now recreate it very accurately, thanks to good old

mathematics, within the computer. This not only saves money, but our environment as well. Other applications, like product design and testing can also take place right within the computer. Even aircraft can be completed designed and tested in virtual wind tunnels, without even building a real life model of it.

So where does this immense source of computing power come from? SGI has developed their own processor, MIPS. It uses a RISC (Reduced Instruction Set Computing) architecture, although SGI also has CISC (complex Instruction Set Computing) processors for more intensive uses. Another very important factor is the bus speed of their computers. They are vastly faster than PC's and Macs. PC and Mac processors actually spend a lot of time waiting for data to get to them because their bus system is slower than the CPU. Think of it this way. SGI workstations have a straight rail line that a bullet train that can travel more than 500 km/h on. This train carries information to the processor from other components such as RAM and the hard drive. Now compared with a PC or Mac, they only have a regular city transit bus, that only travels around 100 km/h.

Now because more advanced graphics and simulations are usually run on SGI workstations, RAM becomes a bigger concern. In most cases one sees at least 512MB of RAM or higher, into the 2GB range. Particular SGI super computers can actually have upto 1TB (1024GB) of RAM! Hard drive storage space requirements also depend on what is being produced. Animation and graphics created for television would probably not require as much space, however any development for film would. In these cases one would most likely see stacks of hard drives. As for outputting images to the monitor, SGI's lower end machines gives consumers the choice form some cards. Notably however, SGI has their own Infinite Reality graphics engine, which can render millions of polygons per seond. The vast majority of SGI computers use the Irix operating system, very similar to and based on UNIX. Although there are some Windows NT and 2000 systems available.

One won't find many games for SGI computers, only mostly high end or specialized software is available. Many 3D packages were only for SGI's at first and later ported to other operating systems. Engineering software can often be found for these workstations as well. A company called SDRC has numerous packages for all sorts of engineering applications, from simulating fluid flow

## Terminology to Know

**Polygon** - A shape defined by 3 or more points and edges creating what is usually termed a surface or face on 3D objects. Some software products also support 1 or 2 point polygons for other special effects.

through pipelines, to designing entire offshore oil rigs.

## Software to Consider

It's perfectly fine to only have a 3D package to create any animation or graphics with. However, one would be greatly limited in what they could accomplish. In the following section, we'll take a look at what a 3D artist would require to successfully undertake projects with. This includes software such as paint programs, for texture mapping and photo manipulation and video editing and compositing programs, to finalize projects with. We will also introduce 5 3D software packages as well.

### Strata 3D

<http://www.strata.com/> - Strata 3D is an entry level 3D modeling, animation and rendering package. For any beginner this program is a prime choice. It allows for an easy interface without the clutter of menus upon complex menus. It still however, has some of the more advanced functions found in higher end software products. For example, boolean functions that allow modeling of more complex geometry, metaballs which uses spheres and blobs them together, and radiosity rendering for creating very photorealistic imagery.

### 3D Studio Max

<http://www.discreet.com/products/3dsmax/> - For those who work in the gaming industry, 3D Studio Max is most likely on their shelves of software products. This mid level package has superb control over 3D geometry and advanced controls for animation as well. A robust plug-in architecture allows the use of a great number of third-party special effects software. 3D Studio Max also integrates well with AutoCAD, both products made by the same company. Frequently this can be seen, as the building structure is built with AutoCAD and then visualized with Max. This program is also a modeling, animation and rendering capable package.

### LightWave 3D

<http://www.lightwave6.com/> - Another mid level 3D modeling, animation and rendering program, LightWave 3D has made a very strong name for itself. If one has ever seen the special effects on numerous television series such as Star Trek (other than the original series), Stargate, Babylon 5, and Seaquest, LightWave 3D

has been used. LightWave has been known to have one of the best polygon modelers on the market. It's animation abilities are also quite powerful, especially it has been revamped in the latest versions, 6 and 7. Rendering also stands highly amongst the rest. New technology has been developed by Newtek, the company which produces LightWave, called HDRI imaging, allowing for eye-poppingly realistic images.

## **Softimage XSI**

<http://www.softimage.com/> - Entering the high end area, this software has been used to produce some impressive motion pictures effects, such as those seen in Jumangi for example. This program has an extensive number of advanced controls for modeling virtually any object imaginable. Softimage is also known well for having extremely powerful character animation abilities. Movement is very lifelike and can easily fool the eye. It overcomes problems with other programs like poor geometry handling at joints. You probably won't however, find softimage installed on any ordinary Joe's computer system. Softimage only runs on Windows NT, 2000 or SGI workstations. Its demands are high on the system, as expected with most high end software.

## **Maya**

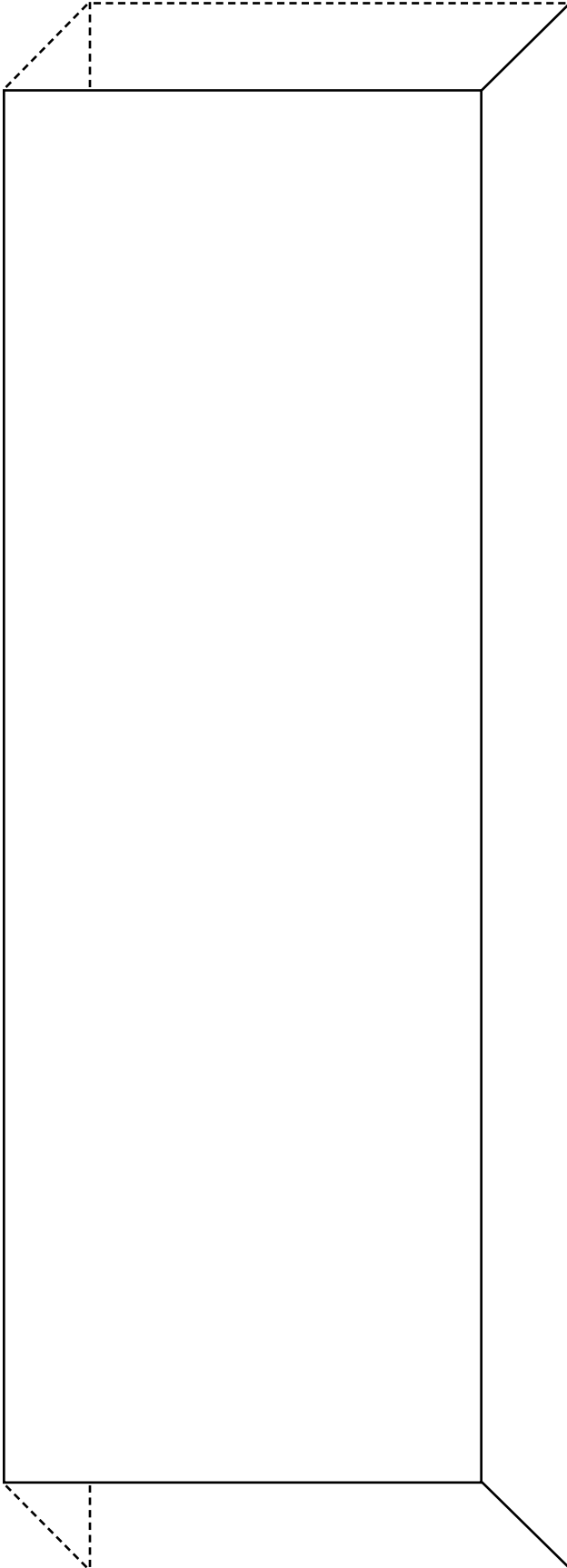
<http://www.aliaswavefront.com/> - One of the leaders in the 3D industry is Maya. It is also one of the most expensive software packages on the market, costing up to \$24 000.00 CDN for the full deal. Almost any blockbuster effects based movie uses Maya for their animation and graphics needs. It has one of the best 3D modelers and supports both polygon and N.U.R.B.S. modes. Maya's character animation abilities go beyond basic surface geometry manipulation, allowing for simulations of very realistic motion and muscle behavior. Again, similar to Softimage, this program will function best with computers on steroids. Windows NT, 2000 and SGI workstations are candidates for this program.

## **Adobe Photoshop**

<http://www.adobe.com/products/photoshop/main.html> - In order to create lifelike textures or add actual photographs to a 3D world, one needs a program to process them. Photoshop is one of the leaders in image manipulation for such requirements. Luckily this program can run on almost any operating system and still works relatively well with computers with less horse power. Numerous filters come with the program to allow for very effects

## **Terminology to Know**

**N.U.R.B.S.** - Non-Uniform Rational B-Spline. A form of 3D modeling that allows for the creation of far more organic objects. This form of modeling doesn't use polygons, instead uses mathematical curves and smooth surfaces.



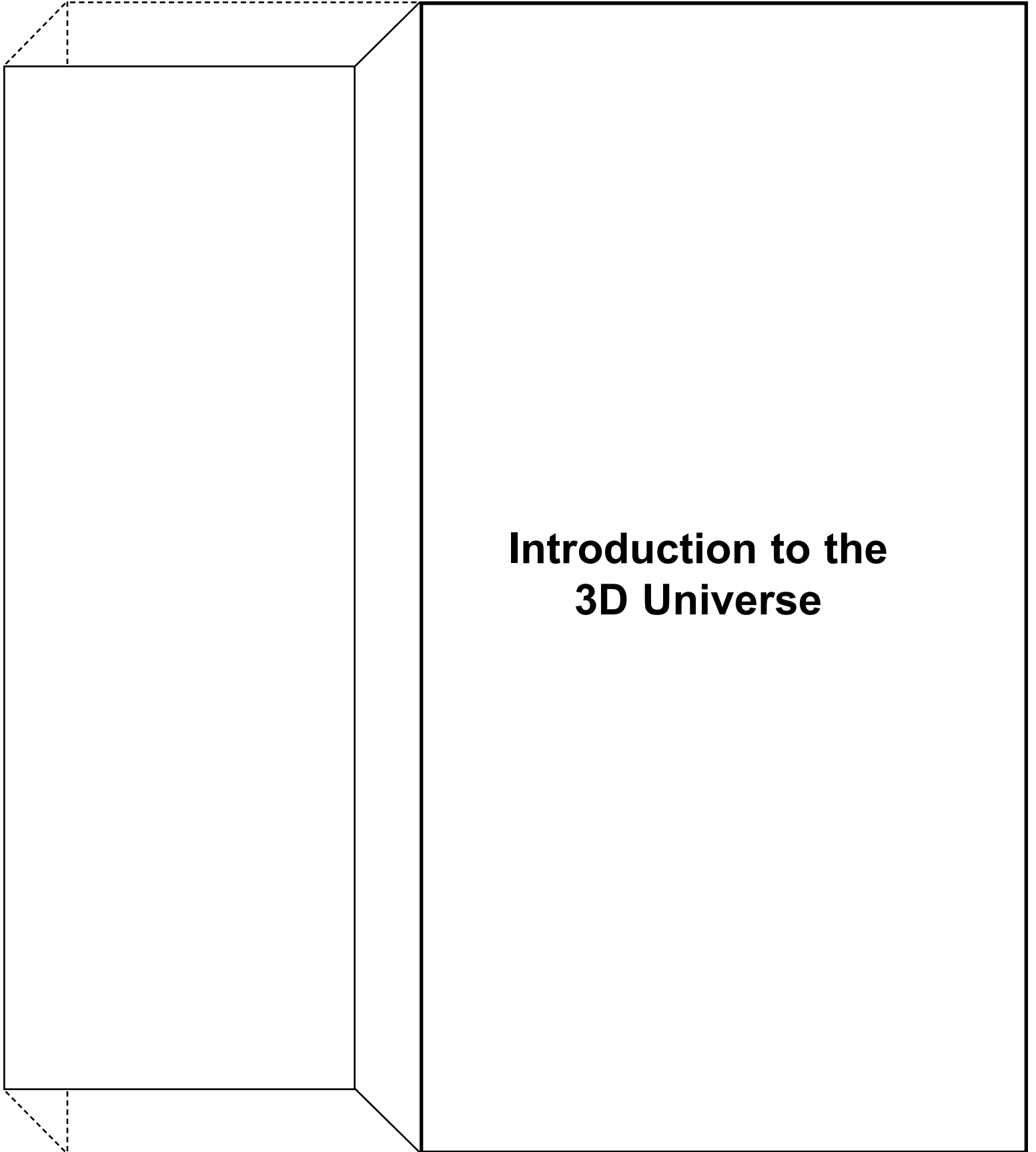
and image enhancement. Third-party vendors also offer additional filters for more specialized uses or effects. Photoshop also supports TWAIN drivers, therefore, users can hook up their digital cameras or scanners to the computer, and through Photoshop launch software to scan and capture images with. Extensive color correction and image repair can then be executed, and saved into one of the many supported file formats.

## **Adobe Premiere**

<http://www.adobe.com/products/premiere/main.html> - 3D has also been a very diverse and growing field. Several years ago, it was far more common for 3D to be used on its own. Today though, more and more often one can see 3D and live footage being used together. Premiere allows these 2 worlds to be melded. Built in abilities include the usual video editing features, over 70 transition effects for use between footage segments, filters for special effects and even video color correction, and an extensive set of compositing functions. In essence, Premiere is used to place all the rendered frames of an animation together, edit that animation along with video or do any compositing if needed, add an audio track (or up to a total of 99 tracks) and then compile them all into one video file for export to film, video or even compresses the video file for use with multimedia productions.







## Introduction to the 3D Universe

## 3D Basics

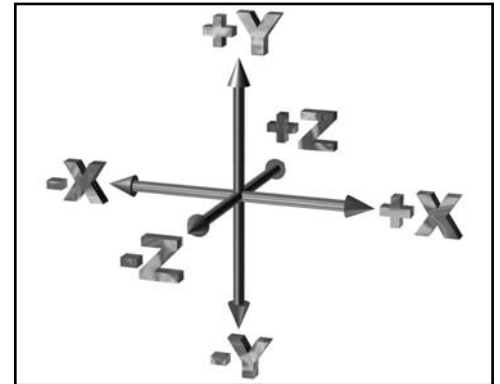
The next sections will describe the need to know basics of working with 3D graphics and animation. Anyone serious about the 3D industry should know these very well. A good understanding of these topics will lead to more productive use of 3D software and better control over the 3D environments. Another great fact to keep in mind, is almost every single decent 3D program out there, is essentially the same. They all have 3 axis, they all have view ports, they all behave similarly. The differences tend to be in where some of the menus are, and one program may have features that another doesn't. Those are what need to be learned separately.

## The X Y Z's of 3D

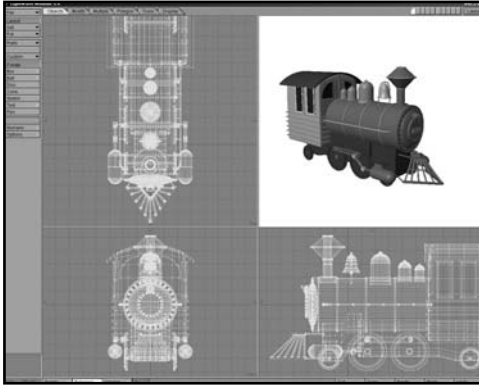
Anytime one works with the 3D world, there are 3 axis that must be understood. Fig. 1 shows what this looks like in a 3D environment. The point through which all axis cross in the middle is call the origin. The coordinates of the origin read 0,0,0 in whatever unit one happens to be using in the software. The 2 usual axis we're used to seeing are X and Y. X is horizontal, with positive units heading the right direction, and negative units left of the origin. Y is vertical, positive numbers up from the origin and negative down. The Z axis is of course what makes 3D unique. It heads to and away from the origin. In most software packages negative numbers are towards us, and positive number head away from us.

These axis are used extensively during any modeling and animation process. When planning or story boarding a project, it usually helps to use a common unit. Most artists tend to choose the metric system, because it's easy and efficient to work with. Another consideration with modeling and animation is gettingt the imagination to the screen. A mandatory practice with professionals in the 3D industry is to draw objects they wish to model from different sides, and to keep them in scale. Grid paper usually comes in very handy for this process. The idea is to pick a unit that works well with the scene, something big enough so the minor details can be worked out later when necessary, and not to small that it becomes a microscopic task. Further tips and information on this topic will be discussed in a later module.

Fig. 1



**Fig. 2**



This is a screen shot taken from LightWave's modeler showing the train object seen on the cover of this module. The views are as follows:  
Upper left - Top  
Lower left - Front  
Lower right - Side  
Upper right - Perspective

## View Manipulation

To some degree, a major difficulty working with the 3D world is manipulating it. The computer monitor is flat. Even with 2 eyes and software that tries to assist us by perhaps shading objects a different color that are further away from us, or simply by adding a stronger perspective, it still isn't real 3D. So to further assist us, most software has view ports that can be manipulated in order give us the ability to look around our objects and see where they are in relation to either a displayed grid, or in relation to other objects. These views can in most cases be zoomed in on and panned or even rotated. Now these views aren't only for seeing objects, we can also reach through them like an open window, and grab those objects and move, rotate or scale them.

## The Major View Ports

Three views are the most essential when modeling or animating in 3D, and they are the top, front and side views. There is also a fourth perspective view as well, to give artists an even better idea of what they've done so far. See Fig. 2. In order for the software to know what the artist wants from it, it needs to "see" the creation from at least these 3 sides. These 3 views can be panned on their respective axis, but not rotated. Objects in these views however, can be rotated, again only on certain axis depending on the view port used.

Now this doesn't just apply to the modeling world, bringing objects to life requires these views as well. How else could one make a roller coaster race along it's winding tracks, without appearing to float off of them. Sometimes it would also be great if one could, in a sense, fly around a specific object. Again this is where the perspective view comes into play. This view can be rotated and for that matter, zoomed in or out as well. Complex objects may require modeling in the perspective view due to hidden and difficult to view angles in the other 3 views.

## Enlightened View

Some 3D packages come with the option of seeing what a light source sees from its vantage point. This feature usually only works with spot light and distant light sources. More on light types later in this module. This handy view can be useful in cases where an artist might want something very specifically lit. By sitting in the cockpit of that light, most software allows you to

maneuver the light into place. In the case of spots lights, the artist may also have the ability of changing the angle of the light beam.

## Camera View

Before any final rendering takes place of a 3D still life scene or animation, one must set up the camera. The camera is exactly what it sounds like. Just as in the real world someone takes a camcorder and begins recording with it. Many software products allow changes to be made to several of the camera's attributes. For example, different lenses can be simulated to achieve zoom and wide angle shots, f-stop numbers can be changed to create focal effects. Cameras usually appear as some sort of an icon. They however, do not render on the final image, so one will not see shadows or reflections of this virtual camera.

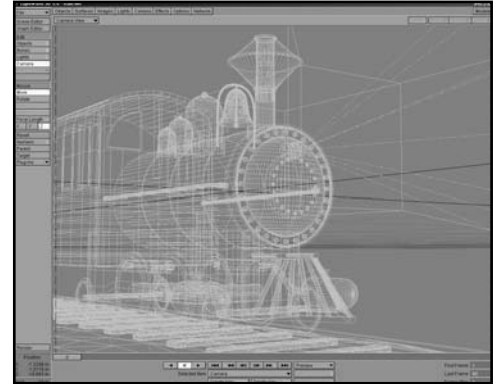
## Open GL

When working with 3D software, OpenGL is a word often heard. Open GL is actually not a view, however, it does assist the user by displaying wireframe geometry as solid entities. Open GL is actually software, a driver usually installed when the 3D software is. Hardware on video cards can assist the CPU when it comes to using it. On some computer systems there may be a significant lag between the user and the screen update when switching to that mode. Hence the important of a good video card. See Fig. 3 for an example comparing wireframe to Open GL. There are several versions of Open GL, some that merely display shaded objects, and those that display fully textured and lit objects.

## Rendering Terminology

The word "render" has been mentioned often throughout this document, but we still do not know exactly what it means. Although true, rendering is when 3D software applies a skin to 3D geometry, which may involve coloring or even texturing the objects, but there are multiple types of rendering methods for different purposes. These purposes may include test runs or quick previews of animation projects to rendering the final output to film, video or even multimedia use. Almost any 3D package out there can either render the frames of an animation to still image files, or even to QuickTime or AVI formats. Rendering is also very CPU intensive, meaning the faster the CPU, the less time the user has to wait for the image to render.

**Fig. 3**



The above shows wireframe. Below we see Open GL being used to display the train.

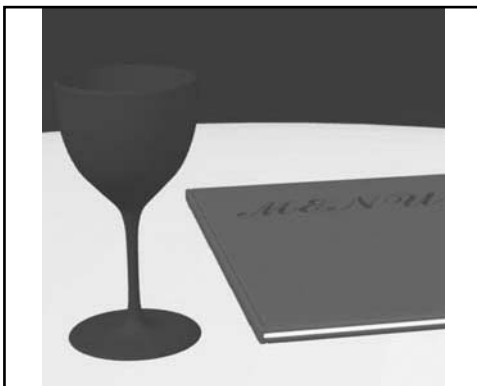
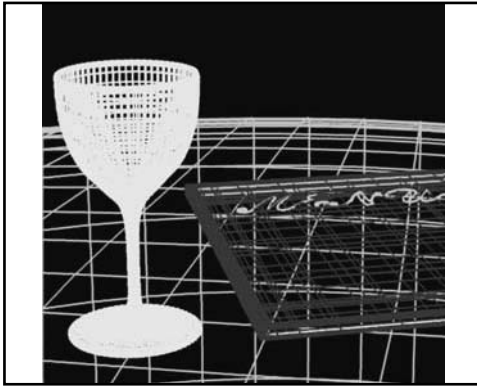


## Common Rendering Methods

Above: WireFrame

Middle: Scanline

Below: Raytrace



## Wireframe and Scanline

Wireframes are extremely useful in the 3D world. Even complex models can be updated quite quickly by most modern CPU's. The CPU must simply draw lines and points, ignoring all color, texture and lighting information. Primary use for this display mode is modeling objects, setting up scenes and doing quick previews. There are times however, for special effect reasons, that some artists actually use wireframe rendering for final output.

There does come a time when the artist might want to see a somewhat better rendition of their work for proofing, without waiting as long as some of the more advanced methods of rendering would take. Scanline rendering, very similar to the look of Open GL, does the trick. Scanline doesn't support shadows, reflections, refractions, and depending on the software used, may not render textures or transparencies. But it does display objects with shades and color. This method is used mainly for testing animations to see if any objects collide with each other, or for giving clients and supervisors a quick idea of how far the artist has progressed with their work.

## Raytracing

The vast majority of 3D graphics and animation are rendered in this mode. Shadows, reflections and refractions of objects are all rendered, including texture and transparency support. The process of raytracing however, can be a very time consuming one which also utilizes far more of the CPU's time. When performing this method of rendering, one should shut down any other programs in operation to conserve the CPU's time. In order to get the more realistic imagery what essentially happens is rays of light are traced from the camera's point of view, back to the light source from which they came from. This operation also takes into account objects in the way, where light would have to bounce off them, hence your shadows and reflections. If software was to do this operation in the opposite direction, meaning tracing the light ray from the light to the camera, the mathematics would be too complex and render times would increase to the point of being unbearable. This method is far accurate enough for even high end 3D animation and graphics.

## Radiosity

For the ultimate in rendering quality, artists would mostly choose radiosity. It has all the abilities of raytracing as mentioned before,

with one substantial advantage. Radiosity rendering also calculates rays of light bouncing off of objects, rays that may not go directly back into the camera. Therefore, the result is a spectacular ambient effect in the 3D scene. To give an example of this, imagine a tree in a grassy field. Using only one light, like a sun, shining against the tree, the shadow would be pitch black using raytracing. Now with radiosity that shadow would be somewhat lighter, with visible details because the sky and ground around the tree scatters some light into the area of the shadow. Architectural renderings usually use this method to see how light would behave in the building structure, before it's even built.

## Anti-aliasing

No professionally rendered image is complete without anti-aliasing. If one is familiar, even a little with graphics, this is a common and important feature. Fig. 4 shows a demonstration of this. The image on the left is not anti-aliased, while the one on the right is. What basically happens here is any edge, especially in some sort of angle, is blended or smoothed to enhance visually what the image looks like. In the majority of 3D software there are several levels or settings that can be used to enhance the image. The more levels over an image, usually termed passes, the greater the time it will take for the CPU to complete an image. Anti-aliasing is usually turned off for previews or test renders.

## Some 3D Special Effects

With the previous section, we've discussed some of the raw basics to 3D. In this section will explore, in no specific order, some of the effects seen in 3D animation and graphics and the general ideas behind them. These next terms are thrown about frequently in the development of story boards and brainstorming sessions before any production takes place.

## Glow and Halos

Fig. 5 depicts a glow on some radioactive liquid flowing out of a barrel. The glow or halo effect is usually a post rendering feature. What this means, is the 3D software first finishes rendering the image, and once done, applies the effect on top of the completed image where needed. This adds time to the rendering, usually not much however. Using glows or halos also brightens the image in the areas it was applied to. General settings to this effect include a glow radius, which is how far the glow will extend from the

## Terminology to Know

**Ambience** - Indirect, scattered or diffused light from the result of photons (light) bouncing off of objects and different materials in an environment.

Fig. 4

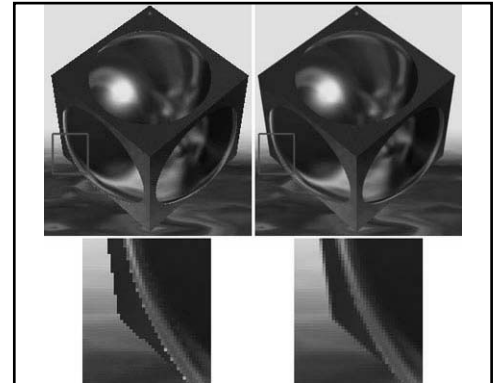


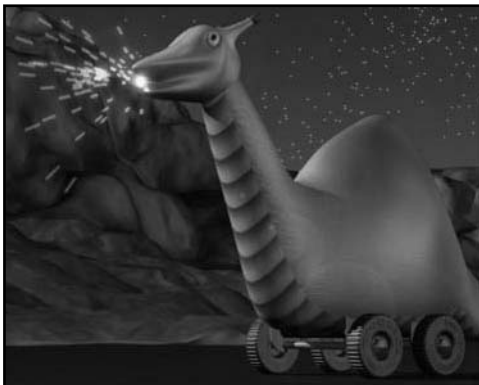
Fig. 5



**Fig. 6**



**Fig. 7**



object it was applied to, and intensity settings, basically how bright one wishes the glow effect to be.

## **Lens Flares**

It is often joked in the industry that artists who use this effect often in their demo reels, will not be employed. Perhaps true to some extent. They may look pretty, but can take away from the scene, instead of adding to it. Lens flare are primarily created from light sources that stare directly into the virtual camera lens. Like glows and halos, this effect is applied to the image once the major parts of rendering is completed. As Fig. 6 depicts, lens flares can have different shapes, sizes, brightness values, and even streaks and lens reflects can be simulated as well. From a design point of view this effect should be used sparsely. Good places to use it are, for example, car headlights, stars or the Sun and can even be used to enhance the epicenter of an explosion.

## **Particle Systems**

If one has ever seen a flock of animated birds, or sparks coming from a 3D welding torch and even perhaps generated fireworks, well all those were all probably created using particle systems. Fig. 7 shows 2 images demonstrating this idea. On top there are a number of fishes swimming. To animate all of these fishes one by one would be possible, but would take a great deal of time. With a particle system however, one can enter a few numbers which then duplicates the fishes, adds random sizing and motion to them, and voila, a very complex scene can be created in moments. The bottom picture shows a particle emitter. This may sound like a sci-fi term, but in fact is used quite often in such effects as the one shown, or to simulate steam or more controlled fog effects and even fire. These particles, usually one point polygons, can even be blurred to give the illusion of quick movement.

In more advanced software, behavioral patterns can also be applied to 3D objects. These patterns may include collision detection, a process that eliminates any chance of objects hitting each other, flight patterns, and even A.I. (artificial intelligence). The latter would be used primarily for games. Say for example the game player swats at a hive full of bees. Those bees could be programmed to fly in directions avoiding contact with the game player's character. They could also be programmed to sting the character if in close enough proximity. These behavioral patterns

can also be applied to the motion picture and television industry as well, saving possibly tens or even hundreds of hours animating a great number of objects.

## Fog and Atmospheric Effects

A great deal of mood and personality can be added to a 3D scene by adding the correct atmosphere. Imagine a spooky 1800's town towards night fall. Which would enhance the look of it more? A clear sky with stars shimmering brightly? Or perhaps a murky gray fog with darker clumps and patches throughout it? Option 2 would be the better choice. Fog has come quite a long way since the old days of 3D animation and graphics. At first fog was simply set by 2 major values, a minimum and maximum distance. Objects behind the minimum distance would begin to fade into whatever color was chosen for the fog. Objects getting closer to the maximum distance setting, would almost entirely be the color of the fog. And of course anything behind the maximum distance set for the fog, would simply be the fog color, hence invisible. This min. and max. value for the fog is always relative to the camera. As a quick final note on fog, underwater scenes also use this same effect to give the illusion of water depth and water quality.

## Motion Blur

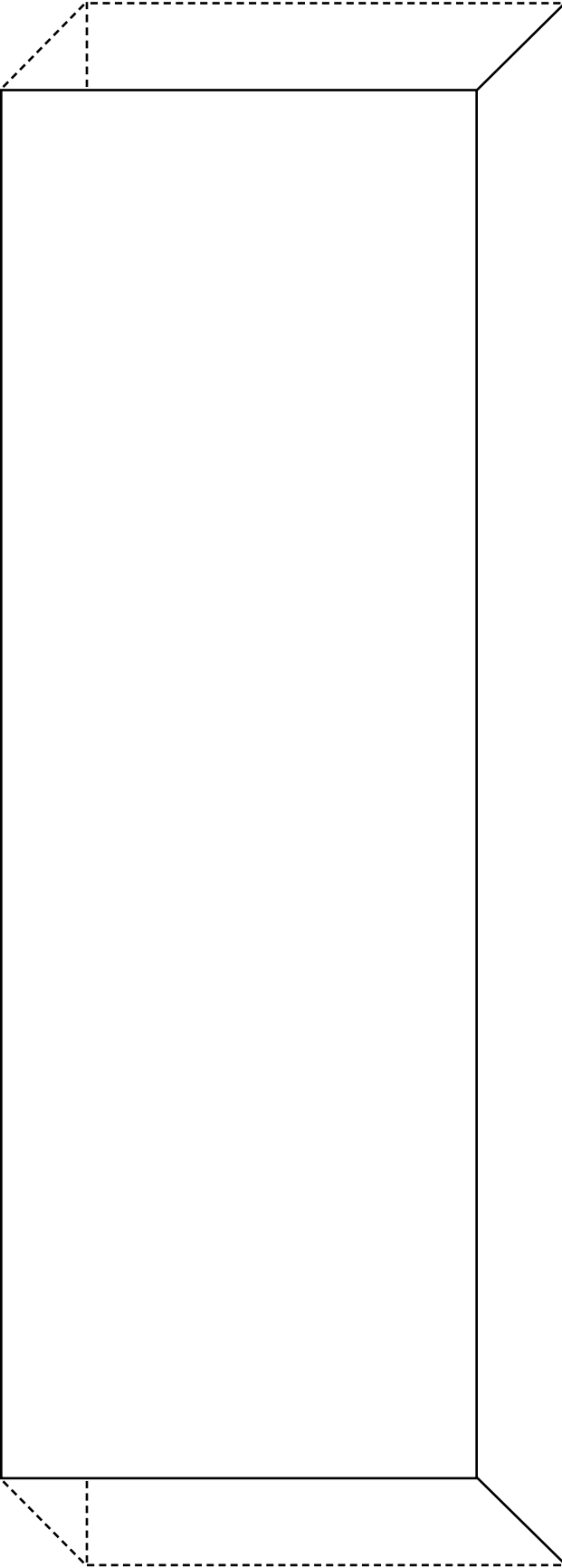
The one major give-away that something is animated, tends to be the clarity and smoothness of its images and movement. So in order to create more lifelike graphics and animation we use motion blur. To understand motion blur we need to understand how a camera works in reality works. Cameras have what's called a shutter, it basically controls how long the film is exposed to light. Now if the shutter speed is set low, for example 1/4 to 1/12 of a second, and the camera is moved during the time the picture is taken, a blurry image will be recorded to the film. A good example of this is pictures of stars. If one points a camera towards the north star and leaves the shutter open for a few hours, the result is a sharp north star and circular streaks of all the rest of the stars.

In the 3D world, software attempts to recreate this by rendering several passes over an image, each time offsetting the scenery and objects (actually the camera is panned or moved, it merely appears that the scenery is being offset). Now by overlapping each of these offsets, and blurring them a bit, the result ends up

**Fig. 8**







looking something like Fig. 8. Note the propeller blades. In a still image it adds the appearance of motion. And with animated creations it adds realism. When compositing animation onto live action footage, an attempt should be made to match the shutter speed of the actual camera used to shoot the live action footage. This makes the animated object look as if it belongs to the scene, rather than a cardboard cutout. And a fair warning when using motion blur, it can also ruin a scene by putting everything unrecognizably out of focus.

## **Focal Effects**

Depth of field is an effect that simulates focusing. Primarily it's used in scenes representing small or microscopic characters and objects. It could also be used where 2 characters might be having a conversation. The focus could be shifted from one character to the other, depending on which character requires it. There are usually 2 settings in general with this function, focal distance and the F-Stop number. The focal distance, is the distance set between the camera and the element one wants in focus. The F-Stop number set the amount of light that enters the virtual camera in the 3D software. In other words, the F-Stop sets a range of focus, anything outside this range, will be blurry. As with an actual camera, the lower this number, the smaller the range of elements in focus. The larger this number, the greater the depth of field.

## **Light Sources**

Lights are one of the most essential parts to either having a great looking animation, or a terrible animation. They can be used to not only light up a scene, but to add depth, mood and visual effects. In almost any 3D scene, there should be a bare minimum of 3 lights. One light is generally used to light the scene as a whole. A second light adds some ambience to the dark shadows the main light creates. This second light is also placed approx. opposite from the main. And finally there is usually a 3 back light, which shines far dimmly than the other 2. However, what if an artist was to create a busy city scape. In that case each street light would have a light source, any vehicle on the road would have several lights attached to it, and then of course add a few more for the sky and ambience, and one could find themselves with 20 to 40 lightsources off the bat! And this is perfectly normal, especially if one takes the time to properly set up each light in the scene to proper colors and intensities, the scene could become a masterpiece.

There is also a fairly substantial misconception about lighting. Most artists, especially beginners, believe that any 3D scene must be very well lit with bright white lights. This may seem alright to do because if the artist took a great deal of time creating the smallest of details in their objects, they would want it to be seen and not lost in darkness. However, by doing so the realism of the scene is lost. It's actually better to have a scene slightly underlit. Of course if one drastically underexposes the scene, that's no good either. Larger special effects studios actually have separate departments that look after lighting. These artists are trained well in the field of lighting and esthetics, who can truly make the elements of a scene shine.

## **Volumetric Lighting and Intensities**

Before discussing the different types of light sources available in the majority of software packages, let's discuss a couple of important settings for them. In most 3D packages, lights do not have what's called a falloff. In other words they simply shine onwards to infinity. This is of course something that doesn't happen in reality. Due to atmospheric conditions, such as the air itself and pollution, light loses its intensity over certain distances. This distance depends on the power of the light source used. Now to compensate for this and to add more reality to a scene, most 3D packages have, what's generally called, a falloff value. This falloff value is a distance input by the artist, that tells the software how far the light will shine for and affect objects. Anything outside this distance will not receive light from that source. The result is a scene that is more true to life.

A few sections back we had a topic about atmospheric effects. Volumetric lighting would practically fit into that genre of effects, as well as it does into the lighting arena. To best describe what volumetric lighting is, we shall use an example. If one has ever seen a high powered spot light, like the ones exhibitions use to shine into the sky, then perhaps one has also noticed how the light seems to stream through the clouds or fog. Or take a flashlight in a dark room, and shake some clothes in front of it, and notice the falling lint and dust sparkles in the beam of light. Some software comes with features like this, and the effects they produce can be quite beautiful. The one downfall to this is rendering them, for it can take quite long! Luckily some features are usually built in to help save time, like turning off anti-aliasing and only using half the resolution to render the effect.

## Common Light Sources

Let us begin with the distant light source. These lights are primarily used as main light or to simulate the Sun. A couple of important details to note about distant lights is that they emit parallel rays of light and emit those rays from an infinitely far distance away. These lights can also be used to simulate ambience, especially if radiosity rendering is not available, or time is too short to render in that mode. Now one might ask the question, what if the artist does wish to simulate ambience, but without the shadows the light would normally cast? Well thanks to most pieces of software on the market, there are options available that allow artists to turn off shadow casting from light sources. Now a more realistic ambient effect can be created.

However, there comes a time in the production of a 3D environment that an artist might want more control over lighting. For this purpose there are spot lights. As with real life spot lights, the angle at which the light shines can be varied, sometimes animated too. These lights can also, in most 3D packages, render out soft edged shadows whereas distant lights usually only produce sharp edged shadows. One also has to be careful about the placement of these lights. If an object is animated and it so happens that the light ends up in the object as it moves by, the light will not shine through the object. To add to the usefulness of spot lights, they can sometimes project images or video files. Think of a movie project for example.

The next light in our list is the point light. The point light may also be referred to as an omni-directional light, for it shines its rays in all directions in a radial pattern, similar to that of a light bulb or our Sun. Uses for this light include some ambient effects and literally, light bulbs. They can also be used to more precisely place lens flares and for other various effects requiring a light that shines in all directions. Linear lights, which are categorized as a separate light source, are actually very similar to point lights. The main difference is these light sources emit light similar to that of a fluorescent tube, outwards in a cylindrical fashion. The ends of the linear light do not emit light, only the portion in between does. This is actually one of the only types of light sources that can be scaled. Artists usually set the length of this light and place them close to objects to generate some very interesting and realistic lighting. Or yes, to simulate fluorescent tubing.

Although there are all sorts of other light emitting objects and items available in various 3D packages, area lights can still be found in most and behave generally the same way. An area light is basically a 2 dimensional square, with only a width and height) that shines light outwards from its flat surface. They can be useful for simulating the effects of radiosity, without the lengthy wait for the rendering to finish. None the less, they do in most cases take long to render compared with the other light sources discussed. Turning off shadow casting will speed up rendering substantially, and perhaps result in better ambient effects.

## Modeling and Animation Terminology

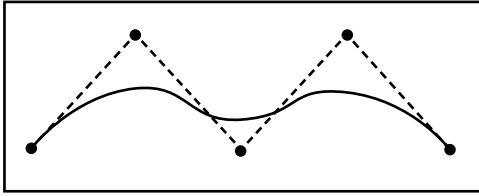
To assist beginners, we have included this section of common modeling and animation terminology. These terms are mostly spoken behind the scenes by artists and those who get involved directly with the creation of animation and graphics.

### I.K. and F.K.

I.K., inverse kinematics and F.K., forward kinematics, are very common terms heard when creating character animation. These animation techniques are used when there is a hierarchal chain of objects. To give an example of this form of linking, think of a robotic arm. The arm begins at the shoulder joint, this would be termed the parent object. It then extends to the elbow and wrist. These 2 joints would be referred to as child objects of the parent. Now how can this be used when animating? Let's use this same example, but imagine now the robotic arm picking up a cup. To animate this an animator could take the shoulder and rotate it, then the elbow and finally rotate the wrist into proper position. This is called forward kinematics, basically the animator starts from the parent object and works his way down the chain of child objects. Although a fairly precise technique, it is very time consuming.

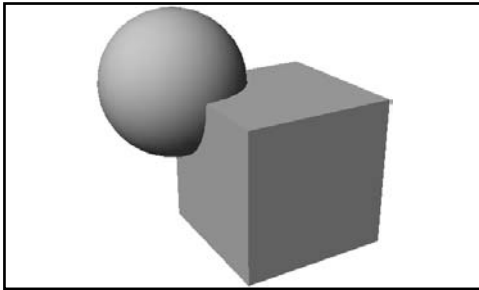
So to save time, the majority of animators use I.K. In this scenario one works backwards, from the last child object back up to the parent. The software does almost all the processing and adjustments required for the remaining child and parent objects. So to take the example of the robot arm picking up the cup, all one would have to do is move the wrist into position and the rest of the arm would follow. Although this method is quick, it sometimes isn't too perfect, but a little tweaking is better than a lot as with F.K.

**Fig. 9**

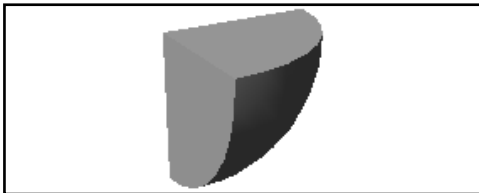


The spline is represented by the solid line. The knots are the black dots that artists can change the weight of, in order to affect the curvature of the spline.

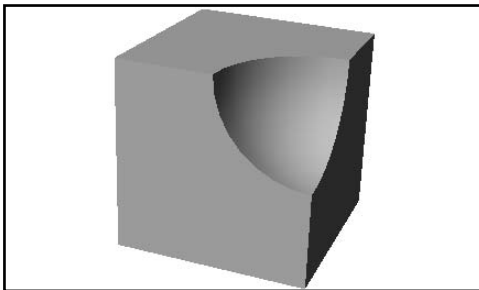
**Fig. 10**



The above shows the original objects used before any boolean operation has been run. However, the Union and Add functions would look identical to this.



Above is the result of Intersect and below shows the Subtract function.



## **N.U.R.B.S.**

N.U.R.B.S. stands for Non Uniform Rational B-Spline. This modeling and animation tool gives artists the ability to create objects with flowing curved lines, versus the clunkier polygonal method. Complex and organic like objects and surfaces can be built this way, and animation created with N.U.R.B.S. objects tend to look very smooth and high end. The idea is that the artist has control points, called knots, that can have their weights adjusted in order to increase or decrease the tension on a spline. See Fig. 9 for a visual example.

## **Boolean Functions**

Boolean functions in most software packages consist of 4 tools. They are Union, Add, Intersect and Subtract. In order to successfully complete a Boolean operation, the artist requires 2 or more objects that intersect one another, or in other words, one object lies somewhat within the other. In most cases, this operation ends up deleting one of the objects, however, this varies depending on which software was used. All of these functions basically modify the objects geometry once the Boolean operation takes place.

To give one an idea of what this looks like see Fig. 10. Union and Add both look the same with one major difference being the way the object's geometry is handled. With Union, any intersecting geometry is deleted, whereas with Add the 2 objects are simply combined. Intersect only retains the portions of the objects that lied within one another, the rest of the geometry is deleted. The Subtract function, possibly being one of the most commonly used of the Boolean family, leaves a hole so to speak. One object is used as the cutter, the example in figure 10 uses the sphere as this, and the other object will be left as the final product. Note how the sphere leaves its mark on the cube.

## **Common Modeling Tools**

In this section we'll briefly list some of the simpler modeling tools that can be found in almost every software package out on the market. Let's begin with the mirror tool. This tool simply makes a duplicate on an object reflected on one of the 3 axis. If one looks in the mirror, the reflection in the mirror would be the final product of this function. Extruding an object adds dimensions to it, literally. The idea is that one takes a flat 2 dimensional object and stretches it along an axis, therefore

adding depth to it along a third axis. This is commonly used for logos, where they are thickened and beveled. Beveling is adding a more stylized edge to an object, versus leaving it blocky and cornered.

If anyone has seen a rendered wine glass, it was probably created using the lathe function. Here the artist draws half a cross section of an object, basically an outline, they wish to make 3 dimensional. This lathe function then spins that outline around one of the 3 axis to creating a 3D object. See Fig. 11 on what would be drawn in order to create a wine glass. Most 3D packages also include a magnet tool for modeling. This tool pulls at the points or even polygons of an object to modify its surface and give the impression of hills or valleys. This operation still keeps the object's geometry intact however. Most of the time there is an effector range and shape that can be set. By changing the values for the range, points even at a further distance will be acted upon. The shape determined how the final product will work. General shapes in include linear, convex and concave.

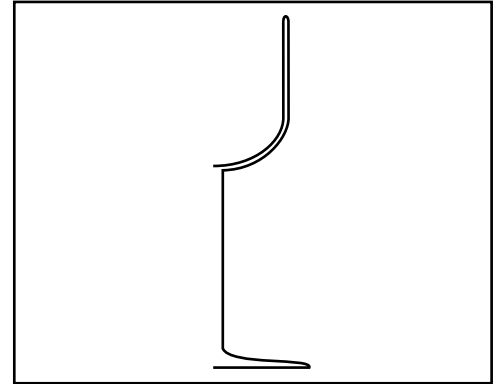
Skinning is another modeling process where outlines are lined up one after another and then have a surface stretched over them. One way to imagine what takes place when one skins, is the construction of a building. There is a frame built first and then the facade of the structure is put on top to hide the frame. This technique of modeling works best with symmetrical objects, like cars for example.

## Object Displacement

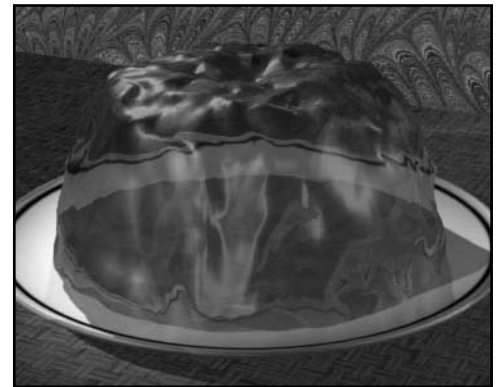
Figures 12 and 13 display 2 different object displacement techniques. Figure 12 shows a gelatin like substance on a plate, and the gelatin's surface is all wrinkled up. This is a mathematical form of object displacement. In most mathematical displacement techniques there are settings that involve wave amplitudes, number of wave sources and the speed of the wave lengths. The software takes care of the math for you and animated the object accordingly. Anyone attempting to create animated displacement, must ensure that the object being effected has a great number of polygons to ensure a smooth look.

Another form of object displacement can be used for modeling 3D objects, using only 2 dimensional images in grayscale. This is demonstrated in figure 13. The top section of the image shows

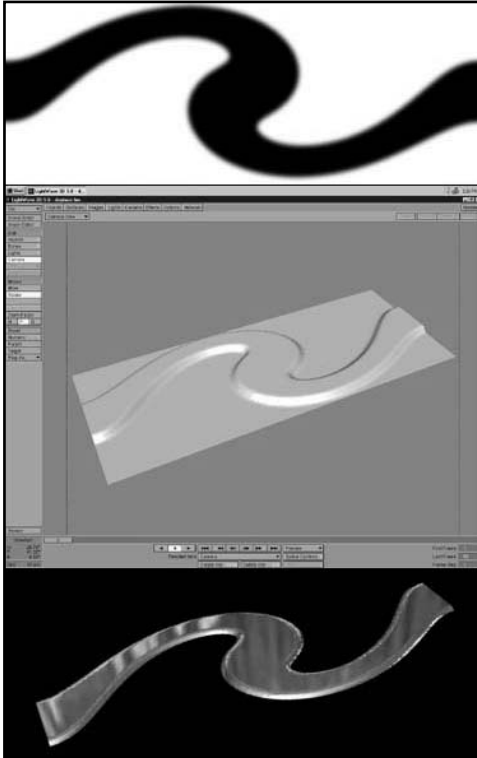
**Fig. 11**



**Fig. 12**



**Fig. 13**



the grayscale image map that is being applied to the 3D mesh, shown in the middle. This image map was created in a matter of moments using Adobe Photoshop and one of its filters. The 3D software basically uses the values in the grayscale image to approximate the height of the new 3D object. White is usually the highest in elevation and black is the lowest (the image in figure 13 is actually shown inversed). Any shade inbetween will be set accordingly. The bottom portion of figure 13 shows the final rendered version of the objects. There is a reflection map applied to the surface to give a metallic appearance.

## Image and Texture Mapping

As much as we've tried to avoid using the words texture and image mapping, we've reached the point where further discussion is required on these interesting topics. Without texture and image maps, 3D objects would pretty much be colored geometry with some shading. Quite boring! The next sections are designed to give a general idea of what mapping means and in what ways it can be utilized. It must be kept in mind though, that different 3D software packages may use these functions slightly differently than what is described here.

Image mapping is where an actual photograph or other raster image is applied to the surface of an object in order to give it a more realistic appearance. Texture mapping still affects what the surface of an object looks like, but deals mostly with mathematically generated shapes, colors and texture simulations. Image maps tend to take up far more memory when used, whereas texture maps only need a small amount, since they mostly consist of numbers and mathematical formulas. They each have their purposes of when best to use them. Image maps tend to add reality to rendered artwork and texture maps can be used for somewhat more distant objects that do not show up as well in a rendered scene. Although, because of advancing technologies in rendering, texture maps may also have benefits over image maps, and for that matter can now also be used for close up shots and still look very realistic. The majority of texture maps use fractal mathematics, therefore, even close up shots look great. One can imagine vector graphics representing texture maps, and raster graphics representing image maps.

Now in order to make these texture and image maps look good on objects, there are different ways of applying maps to 3D

surface geometry. The ones listed below can be found in the vast majority of 3D packages on the market. Some however, have some very interesting and unique features. We recommend visiting the Web sites of these products and doing some good old fashioned research.

## Planar Mapping

Planar mapping, as shown in Fig. 14, is primarily used on flat or cube like objects. This doesn't mean that the object cannot be rounded somewhat, but substantial distortion could occur, ruining perhaps the desired effect. As can be noted from figure 14, image maps and textures can be applied from virtually any direction along the 3 axis. One should also note what can occur with this mapping method. Notice the streaking that takes place on the sides of the cube? Basically the pixels on the outer edges of the image, the photo of the wolf, are being stretched along the sides of the cube. This is normal for planar mapping. And if one is wondering what is on the other side of planar mapped cubes, one will find a mirror image of the raster image used.

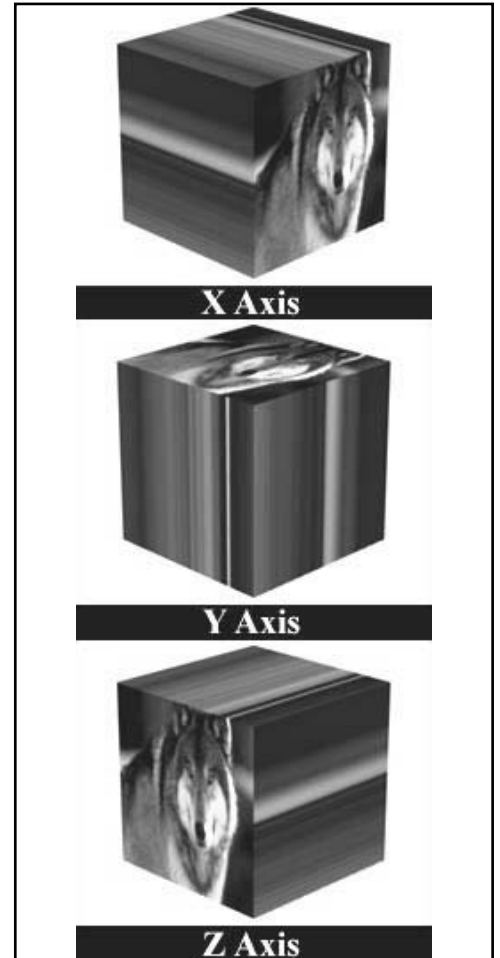
## Spherical Mapping

Figure 15 depicts a sphere being mapped along the Z, Y and X axis, going top to bottom along the examples. Spherical mapping is basically the same idea as trying to wrap a bowling ball up in wrapping paper. The only major difference is the paper isn't overlapped in any areas, instead the image or texture is usually distorted somewhat. This can be noticeable on the example given, especially the top and bottom most pictures. Note the pinching effect that can occur. Spherical mapping is best suited, quite obviously, for objects that are round in nature. But even certain surfaces, like the human face for example, which isn't quite round at all, can still be spherically mapped fairly successfully. It is best to experiment to see what results one can come up with.

## Cylindrical Mapping

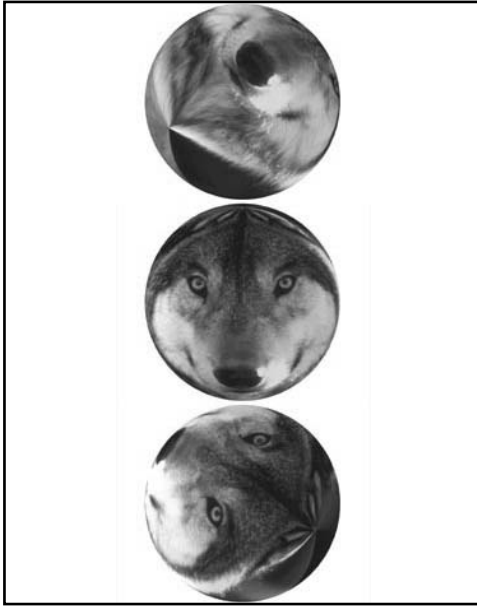
When artists need to map tree trunks or tin cans in a cupboard, cylindrical mapping comes to the rescue. Figure 16 shows an example of a cylinder being mapped on the X, Y and Z axis. Think of literally taking a photograph, rolling it into a tube and then sliding it onto a cylindrically shaped object. There are negative artifacts that associate with this type of mapping as well. Notice how the image of the wolf seems to leave an interesting mark on the tops and bottoms of the cylinders? If the images of

**Fig. 14**





**Fig. 15**



**Fig. 16**



textures aren't applied properly to an object, they may literally slide off of them, leaving a pixel debris trail. To overcome this problem, either size the image or texture a tad bit smaller so it doesn't reach off the object, hide it with larger objects sitting on ends of the cylinder, or even delete the ends of the cylinder, leaving a tube.

## Cubic Mapping

Very similar to planar mapping, cubic mapping actually places the image or texture on all sides of the object without inverting or stretching them in any way. More technically, the image or texture is applied from all 6 sides of an object being the top, bottom, left, right, front and back. Figure 17 more clearly illustrates this on both a cube and a sphere. Notice the effect works better on blockier objects rather than on rounded ones.

## Bump Mapping

Although bump mapping isn't really a mapping method, instead sits more in the realm of visual effects, it's a very commonly used feature. Bump mapping gives the illusion that an object's surface is 3 dimensional, instead of being perfectly flat or smooth. Like displacement mapping, bump mapping uses a gray scale image with the texture or design of the artists choice. Pure white represents the highest areas in elevation, and black represents the lowest. A bump mapped lemon like object is shown in figure 18. The tell tale sign that an object is bump mapped, can be seen on its edges, for they are perfectly smooth. At a distance though, bump mapping is a great thing. It can greatly reduce the number of polygons needed to make the object appear truly 3 dimensional, thus leading to faster rendering times. Another place to use bump mapping, which may even allow for more close up shots, would be if the edges of the object aren't well visible or aren't visible at all. That way there is no reference point for viewers to notice whether or not the object is truly 3 dimensional or just faked with a remarkable illusion.

## Fields of Work in 3D

Once someone has entered the 3D graphics and animation industry, an important question comes up. Where are the jobs in the 3D field? The answer is not an easy one, for the 3D world is a large one. Not only does it exist in the big Hollywood effects houses bring imaginative creatures to life, but also in the medical,

architectural and scientific fields. The police service may use it to solve a crime, to simulate or visualize how it happened. The military extensively uses it to train and prepare soldiers for emergencies and on how to use military equipment. The next pair of shoes one might purchase are probably created in a 3D modeling program.

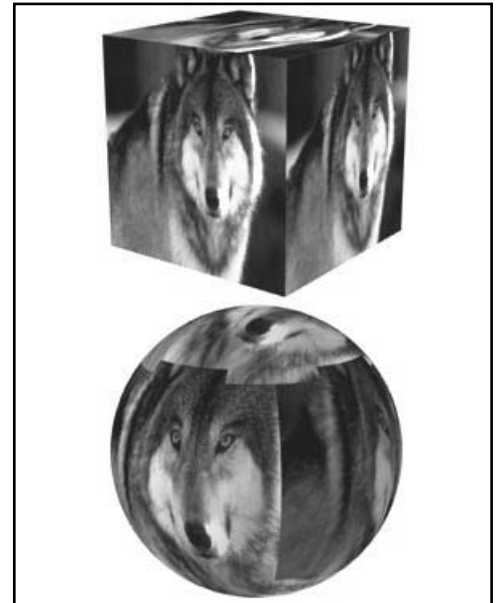
The main concern when one is job hunting, is to have an excellent demo reel. A demo reel is basically an assembled video tape of the artists best animated projects. This reel could also be a single approx. 2 minute long animated short story as well. Judgement, especially in the special effects industry, is very harsh. There are a fair number of artists out there, but only a few stand out who know their field well enough to work in these fast paced environments. In some cases, additional knowledge and certification may be required. For example, a mathematics degree may be needed for a job where one would design instrumentation for oil rigs.

## Motion Picture and Television Industry

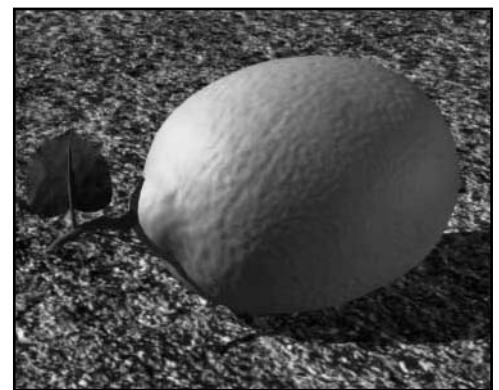
Animation and special effects in movies and television programs constantly amaze audiences across the world. They are probably by far the most fun to create as well. Often are the laws of physics and our world of reality ignored to accommodate the imagination of artists and directors. This industry requires artists from many different backgrounds. Some of these include 3D modelers, texture developers and painters, lighting specialists, general animators and those who specialize in character animation. Now these previous job functions primarily deal strictly with 3D, however there are many other aspects of the special effects world.

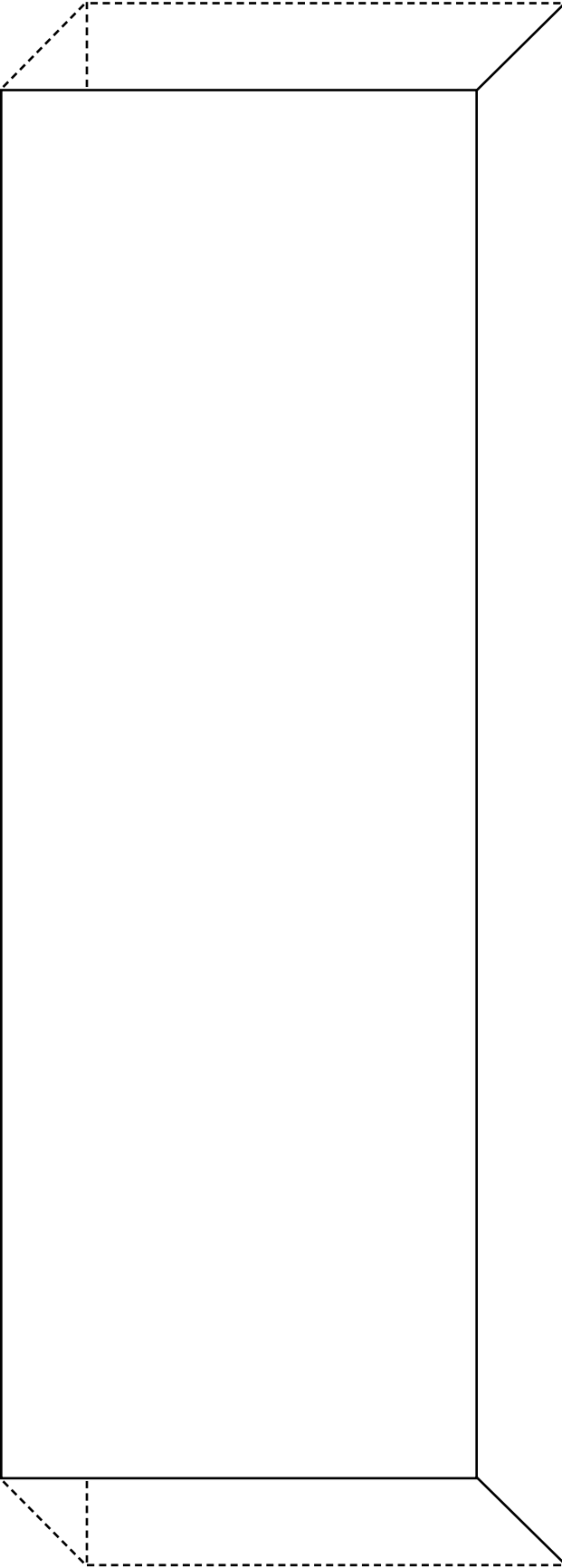
Another unique field has appeared fairly recently which takes some of these animations and effects a step further towards realism. Digital compositing is the process where live action footage is intermixed with digital footage. Almost anyone interested in this field has seen dinosaurs walking amongst us, or alien space craft flying over a city. Compositing may also involve filming actors and actresses against a blue or green screen, and then later removing that screen to replace it with either footage from another shot, or again mix it with animated or painted backdrops. Sometimes compositors may be involved with what's called rig removal. For example, there's some footage with a stunt person jumping off a building, but the safety lines attached to the

**Fig. 17**



**Fig. 18**





stunt person are visible in the shot. Not a big problem any more. Frame by frame editing of the footage can now be easily rendered. In some cases, common software like Adobe's Photoshop and Premiere can even be used.

## **Simulation and Visualization**

Entire aircraft can now be built and tested without the need to create models. The same goes for numerous other products and equipment manufactured these days. Simulations have evolved to a point where engineers can safely and accurately test products for the market, all on computer systems. Computers are becoming so powerful, that they can now handle very complex mathematical equations and can also display highly detailed images and animation in realtime to engineers and developers to examine. This can save both time and money during the phases of product development.

Now simulations may require one to be certified or have a specific degree in their field. However, enter the world of visualization, the fun part to designing products. This step usually occurs before the simulation and testing phases. Many artists in this field truly enjoy it, especially because in most cases they are permitted to express their creativity when designing. And usually it doesn't involve having a very high education either, just a good imagination and excellent understanding of whatever software is being used. Now it's not only products that are designed, like coffee makers and blenders for example, but also such things as the displays used to hold those products. It could make a big financial difference to a company, whether or not the product's stand will attract customers, or simply be ignored by them because it doesn't stand out from the surrounding area and competing products.

## **Forensic and Military Fields**

Law enforcement agencies are becoming more involved with 3D animation and graphics than ever before. Its potential is great in that it can visually depict, from virtually any angle or view point, what exactly happened or did happen at a crime scene or vehicle related accident. There has already been court cases where animation has been used to show the jury what has occurred, and in the majority of those cases the plaintiffs who have used it, have won. Forensic animation, as it is formally known, is currently only produced either by law enforcement agencies and by few

production houses. It still remains fairly expensive to produce such animation. These digital reconstructions don't merely involve an animator with a fact sheet of what happened, but may also involve them to travel to the scene of the crime. These animations are some one of the most precise created. If they weren't, they would be dismissed very quickly by legal officials.

There is also a great variety of military applications that 3D animation and graphics can be used for. This doesn't just include equipment and weapon design, but also training exercises and combat simulations. A great deal of money can be saved by using these computer simulations, instead of actual practice exercises. No one gets hurt here either, nor does the environment suffer.

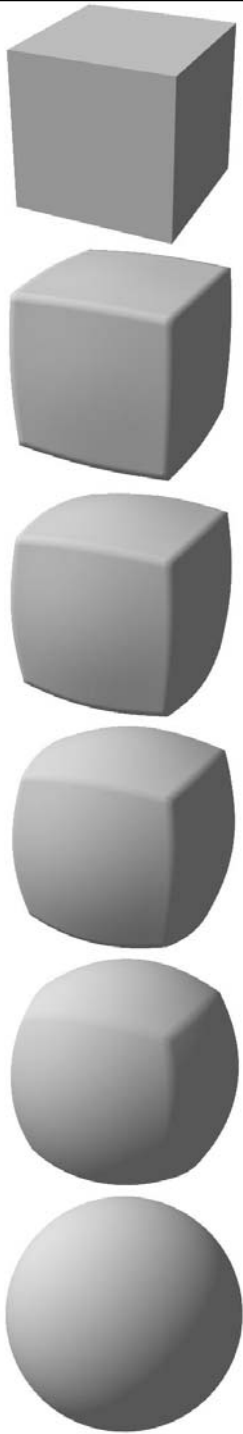
## **Game Development**

At first, most believe that game development only involves a task force of programmers. True, it does involve programmers, but without the help of 3D modelers, animators and texture artists, games would probably not be as exciting as they are today. The task of programmers, aside setting up game engines and proper code for operating system compatibility, is usually to incorporate those 3D elements with user interactivity. For example, when the game player hits left on their joystick, then the 3D character turns to the left and runs. Another use for animation in games which can be seen now and again, are things like intros and animated shots between scenes to introduce new levels or to depict a particular event in a game. These animations seem more like short films with similar production techniques as those used with motion pictures and television programs.

## **Additional Terminology**

Although this section primarily deals with terminology that may not directly deal with the 3D world, it still relates to it one way or another. It is still possible to be a good 3D artist without knowing some of these terms, however, there may be many times where general knowledge is just not enough. Especially important is if one is working or wants to work in the industry. Due to its very fast pace, directors, producers and VFX supervisors don't teach employees how to do things. If the animator or graphic designer doesn't know a term or how to produce that effect, it can be gaurenteed that their stay will be a short one at that company.

**Fig. 19**



## **Morphing and Warping**

Interestingly enough, morphing is not a very new effect at all. When the original Dr. Jekyll and Mr. Hyde film was created (1920's), the actor playing this role contorted his face in order to make it appear as if he transformed into his alter-ego. It was such a transformation that the camera person was reported to faint on the set. Today, transformations like this are done digitally and are referred to as morphing. There are primarily 2 forms of morphing, static or image to image morphing and video morphing, mutating one video segment into another.

With most morphing software, the idea is fairly simple. The artist selects reference points or areas on the starting frame or video segment, and then matches those points and areas up with the ending frame or video segment. The software then goes through a process of stretching or mutating the video's frames until it completes the morphing process. The result is a smooth change from one image or peice of video to the other.

Now how does this tie in with 3D animation? Well figure 19 demonstrates a simple example of this, a cube morphing into a sphere. In some software packages there are certain morphing rules that much be followed, or else the operation doesn't take place successfully. Like In most software packages, the 2 objects being morphed must have the same number of points and polygons. Surfaces can also be morphed in most cases, adding quite a spectacular look. Now there is also the term called tweening. Tweening is also a form of morphing, but it tends to be most recognized as a 2 dimensional form of morphing. Macromedia's Flash software product is a program that has the ability of smoothly transforming one shape into another.

A similar effect to morphing, warping is bascially a controlled distortion of an image. For example, one has probably seen a demonic possension of a person in a television series or two, and has seen the actor or actresses face being streched or pulled in an odd manner. In most cases morphing software can also do warping since the idea is basically the same. The artist establishes control points or areas on an image and then proceeds to manipulate them over a period of time. After the software is done rendering this footage, the end result again would most likely be a video file for output to tape.

## Transitions

A transition itself is quite a simple thing. It's an effect that can be found between 2 video segments, or even between 2 images. Even having a cut from one scene to the next counts as a transition. But that's fairly boring, so to make it more interesting software manufacturers have developed programs like Premiere, from Adobe that have numerous preset effects. There's everything from page turns, to revealing images with blocks to wipes. Most transitions have some settings that can be customized, but to become really creative, one could also develop their own, using 3D software.

## Alpha Mattes

Figures 20a thur 20c demonstrate the main use for alpha mattes. The final product of this example is shown in full size on page 39. The grayscale alpha matte itself is actually shown in figure 20c. Alpha mattes are used when some form of composit work is required. Take our example here. We have a photograph in figure 20a and in figure 20b we have a rendered image of a UFO and its shadow on the ground. To put these 2 pictures together would be quite the task, especially the shadow and the exhaust of the UFO. The trick would be not to get any white edges around the ship when placed onto the photograph.

Now with software capable of compositng, like Adobe Premiere, Media 100 and Avid Systems this becomes a very easy task. These programs recognize the color black as transparent, allowing the background (our photograph) to show through. Anything white will become part of the rendered image (our UFO). Now the parts of the alpha that are not black nor white will be treated as semi-transparent, allowing for some of the background to show through as well some of the rendered image. Take for example, the exhaust trail and shadow of our UFO. It needs to be somewhat transparent or else it won't look very real. Now if this scene was an actual animation, we would need to use what's called a track matte. There is basically little difference between what we've done here and a track matte, other than the fact that track mattes are animated masks. Most software can render the alpha matte and rendered image at the same time, and can even embed the alpha matte into the same image. The proper name for an embedded alpha matte would be alpha channel. Images with alpha channels are usually 32 bits. 24 bits are the RGB color channels and the extra 8 grayscale bits are for the alpha.

Fig. 20a



Fig. 20b



**Fig. 20c**



Actual Photograph. (Not!)

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