

## Techniques for Creating Animations for Technical Presentation

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### Abstract

*In the past, animation was used mainly as a medium for entertainment. However, animation has recently evolved into a highly desirable means for the presentation of technical information, especially if the audience members have non-technical backgrounds. In this sense, animation can be used as a bridge for information flow between the technical community, its management, the political community, or even directly to the consumer. The availability of software tools to easily create animations from solids or surface models gives engineers a unique media for the presentation of ideas, as well as a means for expression of creativity. Also, allowing engineers to create their own animations ensures their technical accuracy. This paper will review some techniques that can be used to improve animations for technical presentation.*

### Introduction

Animation is the sequential presentation of individual graphic images at a rate sufficient to convey an impression of real motion within those images. If the individual images have sufficient detail, and if the rate is sufficiently high, an illusion of real objects in motion can be projected. In some cases, the viewer can control the motion, as with the dynamic image rotation feature found in most solids modeling software programs. This feature allows a pictorial image of a solid object to be rotated and viewed from different angles in real time, giving the viewer accurate visualization of the part. In other cases, the animation sequences are pre-recorded, and particular sequences are replayed upon command, such as by using control buttons. Sometimes sound is added for enriching the presentation.

In the past, animation was used extensively for entertainment. The reason was this use was animation's ability to create characters, objects, places and events that did not exist in reality. But the great skill, time, and expense required to create animations made their casual use prohibitive. However, solids modeling and animation software has recently made it possible to create animations with much less

effort than in the past. The use of animation has thus evolved into a highly desirable means for the presentation of technical information for the following reasons:

- 1 It offers unparalleled clarity in the explanation of assembly and operation of devices.
2. It offers an excellent means of presentation of technical information to non-technical audiences.
3. If engineers, instead of artists or technicians, are permitted to create the animations, errors in proper depiction of parts, processes, and operations will be reduced.

It can be used, for example to demonstrate not only the 3-dimensional geometry of engineered parts, but also the way in which these parts can be assembled to make a structure or mechanism. Further, it can be used to demonstrate the operation of a mechanical device. Some clever tricks can be used to demonstrate gas flow or even heat flow. In education, having students graphically create the assembly and operation of mechanical devices is an excellent means for students to learn about these devices. In this sense, a course in technical animation is not only an excellent stand-alone course, but also an ideal complement to a mechanical dissection course.

### Basic Tools

Traditionally, animations were created frame-by-frame. If an animation was presented at a rate of 30 frames/second, thirty separate images, or cells, were needed to produce one second of animation. This was a lot of work. Usually, a master animator would make the outline of the artwork, and apprentice animators would add the color. This required skilled labor and was expensive. Fortunately, computers and software have greatly reduced the time and effort required to produce the necessary images.

With the advent of software such as 3D Studio™, only the keyframe images needed creation. Keyframes are “perfect” frames that specify the precise location of objects at several important times in the animation. The intermediate frames, between the keyframes, would then be created automatically by the software. The software also allows for objects to be created within the software, or imported from other software. The ability to create or import three-dimensional objects within the software and manipulate location and rotation of these objects were important features that greatly reduced the effort required in making an animation. Most animation software have provisions for the following features:

1. Materials and material mapping of colors and images onto objects.
2. Lighting control.
3. Camera control.
4. Control of entry and exit rates for object translation and rotation to/from keyframes.
5. Kinematic control of time, and object position, and rotation.
6. Rudimentary dynamics, considering the mass of an object and the forces applied to it.
7. Linking and constraints to motion of objects relative to one another.
8. Exporting of solids or surface files to external software.
9. Export of final results to commonly used formats.

For engineered devices, however, the object creation facilities in most animation software is difficult to use. Fortunately, most solids modeling software, such as Solidworks, have facilities for exporting model information, such as in stereo-lithography format (STL), which can be used by animation software. Using a solids modeler is a very efficient creation method for engineered objects. Most solids modeling software now include some rudimentary animation capability that is very easy to use and is capable of demonstrating basic assembly and operation. For a great percentage of presentations, this internal capability is more than adequate.

### For Technical Adeptness...

Once an animation is completed and its distribution has begun, the original pre-rendered files will likely see little further use. The final, rendered production will probably be the version that will see wide distribution, and thus any additional effort to improve this version will be well worth the effort. For rendering of the final work, the following advice is forwarded for technical adeptness:

**Use AVI or MOV.** The final file format should be in Windows Media™ or QuickTime™ formats. These are the most popular formats for video on computers today, and result in the widest distribution and maximum utility. Other formats can, if necessary can be extracted from Windows Media or QuickTime.

**Keep the resolution high.** Although it is sometimes tempting to reduce the resolution in an attempt to save rendering time and space, in general this is not a good idea. As long as the rendering times and file sizes are tolerable, higher resolution is better. If rendering time is a real problem, other means such as eliminating the calculation of unnecessary shadows or reflections can be employed. Low-resolution versions can be extracted from high-resolution versions in the future, if needed, but not vice versa. For presentation on a computer a minimum reso-

lution of 640x480 pixels is recommended

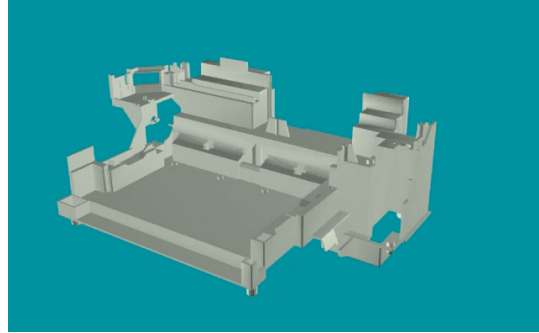
**Use at least 15 frames/second.** The frame rate should be at least 15 frames/second for presentation on a computer. This rate is the minimum before significant image “jumping” between frames is noticed. For more professional productions, the frame rate should be 30 frames/second, which is the NTSC standard.

**Use video compression, but only once.** With most animations, the use of a video compressor will reduce the file sizes by a factor of 10 – 20 times, with little loss in resolution. An animation that is over 700 Mb in size can be unwieldy. It takes a long time to load, and doesn’t fit on a single CD. A good file size would be less than 100 Mb. The Cinepak and Sorenson video compression algorithms (CODEC’s) are the classics, work rather well, and come standard with Windows Media and Quicktime. Indeo seems to be a bit better for animation, but the later versions need to be purchased. Use compression as the final step before production of the final version. Repeated compressions result in severe loss of resolution.

**Use at least 24-bit color.** The deeper the color resolution, the better everything will look. 8-bit color is generally insufficient to present realistic colors and textures. A color resolution of at least 24-bits is recommended. Beyond 36-bits, there is very little to be gained for the added computation time or file size.

### Improving the Presentation

Presentations can be further enhanced by careful attention to details and also by using techniques to make the animation more interesting, engaging, and even entertaining. A basic assembly animation shows a device being assembled and working. If the camera shows only a single angle, and the parts assemble only in a linear fashion, the presentation is still useful, but also boring. The following recommendations are forwarded for improving the presentation of the basic infor-



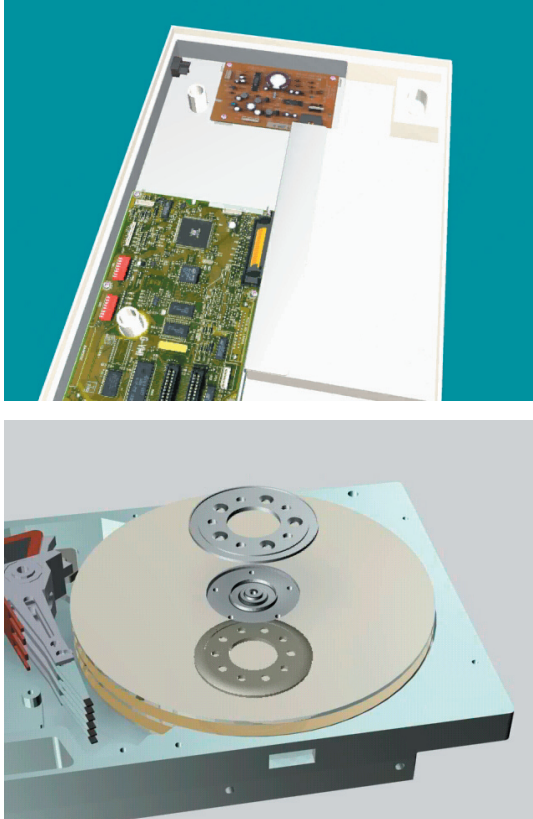
**Figure 1** Solids modeling makes it easy to create accurate detailed parts

mation contained in a technical animation:

**Add sound.** The addition of sound dramatically enriches the presentation. Use good quality sound. Sound at 16 bit, 22 kHz bandwidth should be fine. Stereo is usually unnecessary for computer presentations, and will double the size of your audio file. Instrumentals usually work better than vocals, although either or both are acceptable. Try to cater to the tastes of the target audience, and try to avoid stuff that is too new or controversial. Remember that in the field, a technical, engineering presentation will likely be to a fairly conservative audience.

**Make accurate models.** Are all the parts there? Are all the features of each part there? Sometime in the future, the animation may be examined by someone, frame-by-frame, for completeness and accuracy. If this happens, you’ll be glad you took the time to be accurate. With solids modelers, the creation of accurate parts should be easy, as shown in Figure 1.

**Make the materials accurate.** Metal should look like metal, and not like plastic. Rubber should look like rubber, not metal. Many stock material maps are available as part of the solids modeling or animation programs. Many devices being modeled will have PC boards, and it is usually a simple procedure to scan the boards to get an image map that can be applied to a surface. Adding 3-dimensional components to a PC board also serves to improve realism. But be sure

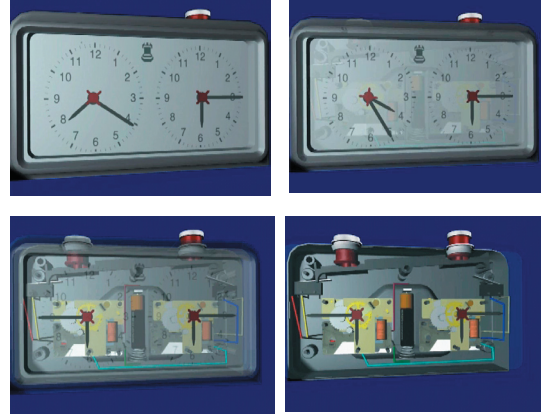


**Figure 2** Accurate materials modeling. Artwork on a PC boards (above), reflection from a polished surface (below).

to scan with enough resolution to match the quality of the other parts. Low-resolution PC boards look out-of-place if the rest of the materials have good resolution. If a surface is highly reflective, this property should be demonstrated. Examples of surface mapping and reflection are shown in Figure 2.

**Make the motion interesting.** By moving and rotating the objects and camera, not only is the motion more interesting, but it also allows for more details of the objects and assemblies to be revealed. This adds to the sense that the objects are indeed real and 3-dimensional. Some animation software allows for objects to be deformed or morphed. If object deformation is a part of the assembly process, it should be shown.

**Use visibility.** Having parts appear and disappear at strategic times is a very dramatic presentation method that will make the animation more interesting.

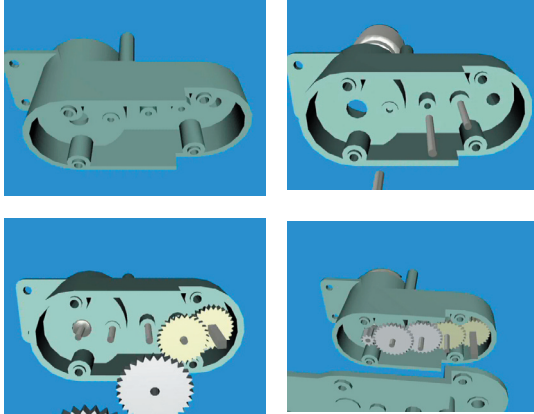


**Figure 3** Dynamic transparency can be used to reveal interior detail

**Use transparency.** Once a device is assembled, or even during partial assembly, it may be difficult to see what's happening. Turning the covering parts transparent or partially transparent at strategic times can solve this problem. An example of a dynamic transparency sequence is shown in Figure 3.

**Use a slow steady pace for your assembly.** If the animation is too fast, not only is it confusing, it is not doing its job of demonstrating assembly. Do not try to hide something by going so fast that the viewer can't see it. It will be seen when it is examined frame-by-frame. If the animation is done in segments, make sure that the pace is somewhat the same for each segment. Of course this does not mean you should only go at a single pace. A very successful presentation technique is to adjust the pace of the animation to match the pace and beat of the music used. Motion can be synched to the beat of music.

**Be sure the assembly sequence is correct.** Make sure you are assembling your parts in the correct order, as shown in Figure 4. If the project is supposed to be a demonstration of assembly and operation, and assembly is done in the wrong order or incorrectly, the animation will fail its intended purpose. If you are uncertain of the proper assembly process for your project, it would be a good idea to find out.



**Figure 4** Animation can be used to show the proper assembly sequence of parts.

**Make the surrounding environment interesting.** Place the device in its intended operating environment, for example as shown in Figure 5. It is easy to download 3-dimensional models of things like tables chairs, lamps, even entire rooms or houses from the Internet, or from commercial software library files. However, do not make these items the main focus of the animation. For more commercial applications, it is advisable to add leaders and trailers that contain the title and credits for the work.

**Discontinuities in the animation are bad.** This is a particular problem with projects that are done as a group effort. One common method of dividing the workload for a group project is to have each person contribute a different part of the animation. If this is done, be sure that the individual sections come together to make a single seamless animation for the final project. Too often it is very easy to tell when one person is finished and another person begins. In the worse cases, the animation abruptly ends with the parts, and sometimes the music, disappearing, and a new set of parts suddenly appearing. Easy solutions to the segment patching problem include having the camera pan to a blank screen and then onto the new parts, and moving or fading the parts out of the scene and then moving or fading the new parts onto the same scene. If this is done, keep in mind that when the camera pans off a certain set of parts, the viewer is



**Figure 5** Showing objects in their intended environment gives a sense of realism and utility to the device.



**Figure 6** Dynamic spotlighting can be used to draw attention to areas of interest.

left in his or her head with a certain expectation for camera speed, direction of motion, and zoom. The new parts should enter the scene with about the same settings, otherwise it is confusing for the viewer.

**Don't go overboard with the camera motion.** If fact, don't go overboard with any motion. Once it is discovered how to control motion, it is often tempting to use a lot of it. Some variation in the motion makes the production more interesting, but too much, such as continuously circling an assembly at a fast rate, makes the viewer dizzy.

**Use variation in lighting.** Spotlights, variation in light intensity and color, and moving lights can be used to emphasize or call attention to certain features that need emphasis. An example of a moving spotlight is shown in the sequence in Figure 6, where attention is to be drawn from one area to another.



**Figure 7** Airflow can be simulated with moving arrows

### Show things you can't normally see.

Animation can be used to help visualize things that can't normally be seen. For example, thermal gradients in a part can be shown by changing its color and color distribution. Airflow can be simulated with moving arrows, as shown in Figure 7. Very small motions can be emphasized with lighting and motion arrows.

### Concluding Remarks

Unfortunately, some animation software do not have segment patching facilities. This means that if you are trying to patch together a series of smaller animations to create a single large animation, you need to another software package. Two software packages can be recommended. The first is QuickTime Pro™. QuickTime is an Apple product. The player is a free download from the Apple website, but all it does is allow you to play an animation. To do any sort of editing, patching, sound addition, etc., you need QuickTime Pro, which is a modest cost upgrade. QuickTime is very easy to learn. The second package recommend is Adobe Premier™. It does everything but is expensive, and has a rather steep learning curve. Fortunately, on most new computers, including HP™'s and Sony™'s, video-editing software of various flavors is included. Also, there is apparently a lot of shareware available from the Internet for this purpose. In general, you are pretty much free to use anything that works.