How 3-D Graphic Work?

You're probably reading this on the screen of a [computer monitor](https://computer.howstuffworks.com/monitor.htm) -- a display that has two real dimensions, height and width. But when you look at a movie like "Toy Story II" or play a game like TombRaider, you see a window into a three­dimensional world. One of the truly amazing things about this window is that the world you see can be the world we live in, the world we will live in tomorrow, or a world that lives only in the minds of a movie’s or game's creators. And all of these worlds can appear on the same screen you use for writing a report or keeping track of a stock portfolio.

How does your computer trick your eyes into thinking that the flat screen extends deep into a series of rooms? How do game programmers convince you that you're seeing real characters move around in a real landscape? We will tell you about some of the visual tricks 3-D graphic designers use, and how hardware designers make the tricks happen so fast that they seem like a movie that reacts to your every move.

A picture that has or appears to have height, width and depth is three-dimensional (or 3-D). A picture that has height and width but no depth is two-dimensional (or 2-D). Some pictures are 2-D on purpose. For example, symbols are designed so that you can recognize them at a glance. That’s why they use only the most basic shapes. 2-D graphics are good at communicating something simple, very quickly. 3-D graphics tell a more complicated story, but have to carry much more information to do it.

For example, triangles have three lines and three angles -- all that's needed to tell the story of a triangle. A pyramid, however is a 3-D structure with four triangular sides. Note that it takes five lines and six angles to tell the story of a pyramid -- nearly twice the information required to tell the story of a triangle.

For hundreds of years, artists have known some of the tricks that can make a flat, 2-D painting look like a window into the real, 3-D world. You can see some of these on a photograph that you might scan and view on your computer monitor: Objects appear smaller when they're farther away; when objects close to the camera are in focus, objects farther away are fuzzy; colors tend to be less vibrant as they move farther away. When we talk about 3-D graphics on computers today, though, we're not talking about still photographs -- we're talking about pictures that move

If making a 2-D picture into a 3-D image requires adding a lot of information, then the step from a 3-D still picture to images that move realistically requires far more. Part of the problem is that we’ve gotten spoiled. We expect a high degree of realism in everything we see. In the mid-1970s, a game like "Pong" could impress people with its on-screen graphics. Today, we compare game screens to [DVD](https://electronics.howstuffworks.com/dvd.htm) movies, and want the games to be as smooth and detailed as what we see in the movie theater. That poses a challenge for 3-D graphics on PCs, Macintoshes, and, increasingly, game consoles like the Dreamcast and the Playstation II.

For many of us, games on a computer or advanced game system are the most common ways we see 3-D graphics. These games, or movies made with computer-generated images, have to go through three major steps to create and present a realistic 3-D scene:

1. Creating a virtual 3-D world.
2. Determining what part of the world will be shown on the screen.
3. Determining how every pixel on the screen will look so that the whole image appears as realistic as possible.

A virtual 3-D world isn't the same thing as one picture of that world. This is true of our real world also. Take a very small part of the real world -- your hand and a desktop under it. Your hand has qualities that determine how it can move and how it can look. The finger joints bend toward the palm, not away from it. If you slap your hand on the desktop, the desktop doesn't splash -- it's always solid and it's always hard. Your hand can't go through the desktop. You can't prove that these things are true by looking at any single picture. But no matter how many pictures you take, you will always see that the finger joints bend only toward the palm, and the desktop is always solid, not liquid, and hard, not soft. That's because in the real world, this is the way hands are and the way they will always behave. The objects in a virtual 3-D world, though, don’t exist in nature, like your hand. They are totally synthetic. The only properties they have are given to them by software. Programmers must use special tools and define a virtual 3-D world with great care so that everything in it always behaves in a certain way.