WHAT IS WRONG WITH 3-D?

3-D movies currently shown in movie theaters are stereoscopic. When you look at a real scene with one eye closed, you will only see in two-dimensions. If you switch eyes, each eye sees the same two-dimensional scene from a slightly different viewing angle. When you open both eyes, your brain interprets the scene as being three-dimensional

Sir Charles Wheatstone presented a paper at a meeting of the Royal Society in 1838 describing a stereoscopic viewer. This type of viewer is called a Wheatstone stereoscope. A year earlier, Daguerre invented the daguerrotype. Sixteen years earlier, Niepce was the first person to invent photography.

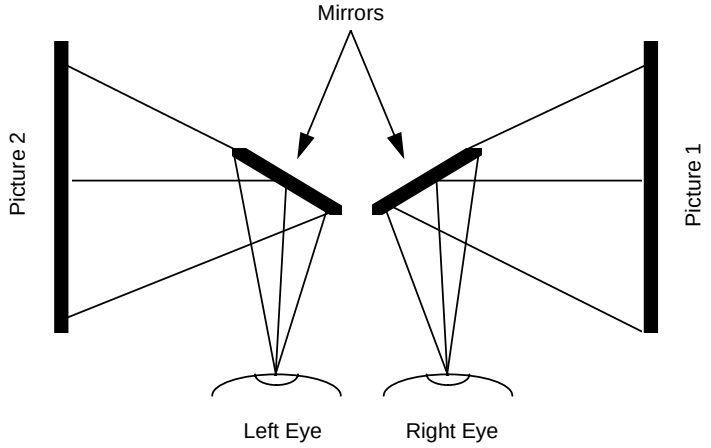

Figure 1 - Wheatstone Stereoscope

The principle of the stereoscope is to present each eye with a two-dimensional picture from a stereoscopic pair. A stereoscopic pair of pictures is formed from two pictures, each one of the same scene, but viewed from a slightly different perspective. The pictures can be photographs or drawings. If the pictures are identical, the scene appears two-dimensional. But, because the pictures are slightly different, the human brain merges them into a single pseudo three-dimensional scene.

Stereoscopes have evolved since 1836. They are still in use. The most popular stereoscope today is the View-Master viewer. It was originally manufactured during the 1950's by GAF.

Figure 2 - View-Master Stereoscope

Figure 3 - View-Master Reels

Figure 4 - A Typical Stereoscopic Pair

Figure 2 shows a modern version of the View-Master stereoscope. It uses circular reels comprising seven stereo pair photographs on 16 mm film. There are fourteen individual pictures (see Figure 3). Figure 4 shows a typical stereoscopic pair of photographs. Note that the pictures are slightly different

(observe the background; and more of the subject's left ear is visible in the right photo than in the left).

3-D is a stereoscopic process. The movie frames exist in stereo pairs. Usually, the stereo pairs are photographed using a single camera having two lenses that are separated by a fixed or variable distance. This is shown in Figures 5 and 6.

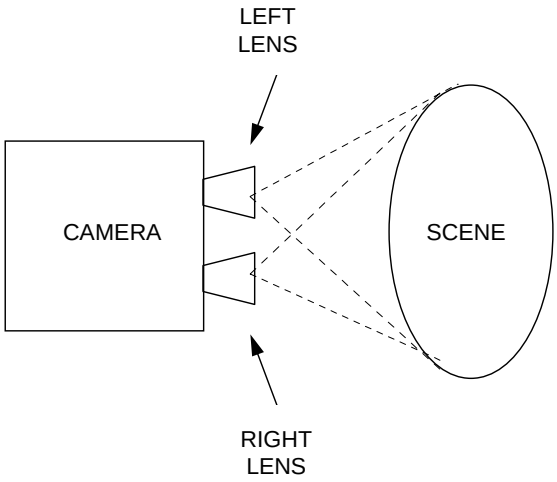

Figure 5 - Photographing in 3-D

Figure 6 - 3-D Camera

The left and right lenses view the scene from a slightly different viewpoint. This is similar to how human eyes view a scene. A person's eyes are separated by an interocular distance. The mean interpupillary distance (IPD) is 63 mm (about 2.5 inches), but this varies with age, race and gender. By adjusting the distance between the camera lenses, three-dimensional objects may appear either behind the plane of the screen or in front of the screen. Ideally, each of the two 2-dimensional images should be presented to each eye of the viewer so that any object at infinite distance seen by the viewer should be perceived by that eye while it is oriented straight ahead. A viewer's eyes should neither be crossed nor diverging. This would minimize eye strain. However, the 3-D effect would be less dramatic.

People having normal vision see the world in three-dimensions, and use the following cues to judge distance to and between objects:

- stereoscopy;
- perspective;
- shading;
- focus;
- convergence; and
- parallax.

The first three cues exist in all 3-D movies. 1) Stereoscopy exists where each eye views the same scene from a slightly different viewpoint. 2) Perspective exists where objects that are farther away appear smaller than closer objects. 3) Shading helps to determine the contour of three dimensional objects.

The last three cues are absent from 3-D movies and all stereoscopic pictures. When we view an object in real everyday three-dimensional space, our eyes focus on that object. Everything else is blurred (out of focus). When we next look at a second object, we focus on that object, and the first object appears out of focus. This is illustrated in Figure 7.

Figure 7 - Selective Focusing

Notice that the bust of Thomas Edison appears in focus. The nearby electric light bulb and the stock ticker are relatively in focus (but not quite) only because they are close to the object in focus. However, the background motion picture projector, the phonograph, and the fluoroscope are all out of focus.

In a 3-D movie, the cameraman selects the conditions of focus. Generally, the entire scene appears in focus. When a viewer of a movie cannot select the point of focus himself, the three-dimensional scene appears unreal.

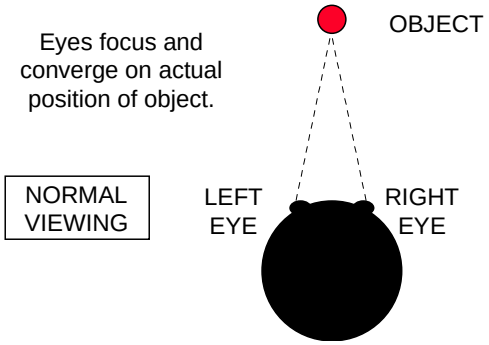

Figure 8 - Convergence

Convergence exists where both eyes look together at a single point in three-dimensional space. When a person normally looks at an object, both eyes converge and focus on the object.

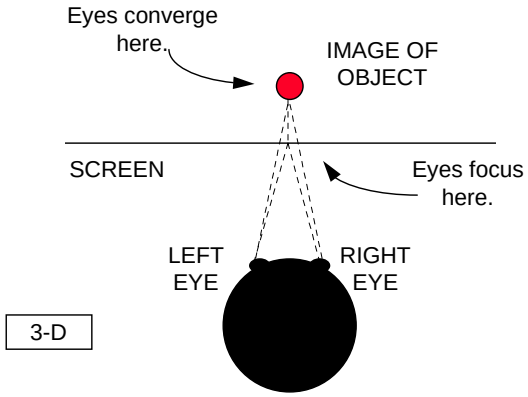

Figure 9 - Abnormal 3-D Viewing

In a 3-D movie, a person's eyes both converge to the apparent position of the object. However, they focus on the actual position of the object -- the screen. A person's eyes are not used to focusing and converging on different points in space. This is an unnatural viewing condition. It produces eye strain and head aches.

Parallax is the ability to see a scene from a different viewpoint as one moves his head either horizontally or vertically. It permits people to look around objects to see what is behind, what is above, or what is below. 3-D stereoscopic movies completely lack parallax. This makes the three-dimensional scene look unreal.

Currently, 3-dimensional movies require glasses to see the scenes in three-dimensions. The movies are projected onto the theater screen with images designated for both eyes merged together. The spectacle lenses separate the images meant for each eye.

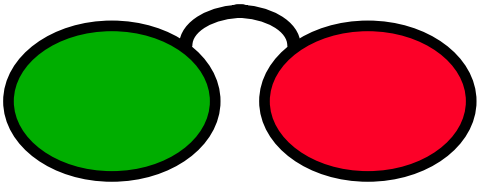

Figure 10 - Anaglyphic Glasses

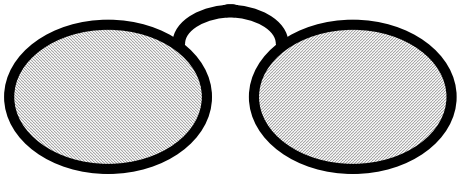

Figure 11 - Polarized Lenses

Two 3-D technologies use different types of glasses. Anaglyphic 3-D projects the two-dimensional images designated for both eyes in different colors. Typically, the colors are red and green, however red and blue are also common. Anaglyphic 3-D movies have been around since the 1930's. A few films were displayed in movie theaters during that time, but 3-dimensional movies were never popular during that period. Figure 10 shows typical anaglyphic glasses where the right lens is red and the left lens is green. When a viewer places the glasses on his nose, his right eye cannot see the green image, and his left eye cannot see the red image. In this way the images are separated. The disadvantage of the anaglyphic 3-D process is that the movies do not exhibit true color. Over the past few years, anaglyphic movies have been shown on TV. The red and blue images are superimposed together over a full color image. With this type of picture, the color is not good, and the three-dimensional effect is diminished.

During the 1950's, 3-D movies were released in full color. The glasses have lenses that comprise two crossed polarized filters. Each filter only permits

light polarized in one direction to pass. The filters are oriented such that when the lenses are superimposed, no light passes through the pair. The polarized glasses are illustrated in Figure 11. The stereo pair images are projected onto an aluminized screen. Each image of the stereo pair passes through a projection lens having a polarizing filter. The aluminized screen retains the polarization direction of each image. The left lens will not allow the picture designated for the right eye to pass, while the right lens will not allow the picture designated for the left eye to pass. Therefore, each eye sees only that image meant for it to see. It does not see the other image.

In the past, 3-D movie projectors used two lenses to project the stereo pairs onto the theater screen. Currently, a single projector having a single lens can be used. The process is the same as is used in 3-D television. Instead of projecting both pictures of a stereo pair onto an aluminized screen simultaneously, the new process alternates projection of each image onto a normal theater screen. The first picture of the stereo pair is projected first, followed by the second picture. The process is repeated thirty times per second. The glasses consist of two lenses fabricated from electro-optic crystals along with polarizing filters. The glasses are battery operated. They are known as shutter glasses. The electro-optic crystals change the polarity of the light passing through it depending upon whether a voltage is applied. Therefore, combined with the polarizing filter, a lens may permit light to pass or may be completely dark.

When the picture for the right eye appears on the screen, an infra red signal is sent to the shutter glasses telling them to prevent light from passing to the left eye. When the picture for the left eye appears, the shutter glasses block light to the right eye. This process occurs with such high frequency that the viewer barely notices the switch. His persistence of vision allows him to see the movie in three-dimensions. However, viewers have complained of flicker.

In all 3-D movies that require special glasses, whether they are anaglyphic, polarizing, or shutters, viewers complain that the pictures lack brightness.

Since the 1920's, inventors developed stereoscopic technologies that allowed viewers to see photographs in three-dimensions without glasses. Until recently, none of these methods have been implemented for motion pictures. Viewing these pictures has been difficult and uncomfortable for viewers despite the fact that no glasses or special viewing aids were used. Recently, companies have experimented with three-dimensional gaming devices along with three-dimensional video cameras on smart telephones. There are rumors that some manufacturers will soon market three-dimensional television sets that do not require glasses. These devices use lenticular screens with stereo pair images. Unfortunately, the three-dimensional images do not appear lifelike or real. People and objects appear like flat cardboard paste-ups in a three-dimensional world, and the three-dimensional world has very little depth. Also, the resolution is very poor.

All three-dimensional processes that use stereoscopic pairs of pictures to produce the illusion of depth must produce eye strain. This is an inherent consequence of stereoscopy. During the 1950's, 3-D movies became popular because depth in movies was a novelty. However, they soon lost popularity, and the process faded away from movie theaters. Patrons complained that the glasses caused them to have eye strain and head aches. In reality, it was not the glasses at all. The eye strain was caused by requiring the eyes to focus and converge at two different places. Those two places were often very far apart.

3-D movies are popular once again. Yet, the same problems still exist. Watching a 3-D movie hurts one's eyes. Yet, movie studios are now committed to 3-D. It would be most unfortunate if 3-dimensional movies once again became unpopular. The problem is not caused by the glasses. It is caused by the stereoscopic process itself.