## Visual Communication Tools

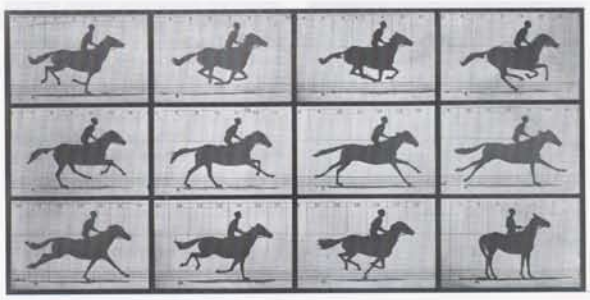
The general "umbrella" term **computer graphics** refers to the entire field of hardware and software that evolved in the 20th century, enabling us to create an image on and with the computer. The term **New Media** is often used to describe digital creations that can combine various forms of communication such as visuals, sound, motion graphics, or interactivity. As artists and designers, we use computer graphics to design and create digital images for a vast array of applications. The doors to new frontiers are opening up as this technology continues to develop new, powerful combinations.

Computer graphics is extending our senses by showing us things we have never seen before in geology, space, medicine, and a host of other areas. The translation of numerical data into visual digital information allows us to see inside storms and along chains of molecules. Computer-generated graphics are now recognized as carrying as much or more information than the linear, printed word. For those who have access to computer equipment, and to the Internet, computer-generated graphics are revolutionizing the way we communicate with one another around the globe. New technology and new ways of seeing are inseparable.

The intent of this chapter is to introduce a sense of the evolution of computer graphics and the digital image and to show computer graphics' relationship to various modes of art and design. Understanding the development of computer graphics and the role it plays in today's world is important to students of art and design. Throughout this text, we'll present the creative partnership between computer tools and the eye and mind of the artist and designer.

### Concept and Innovation

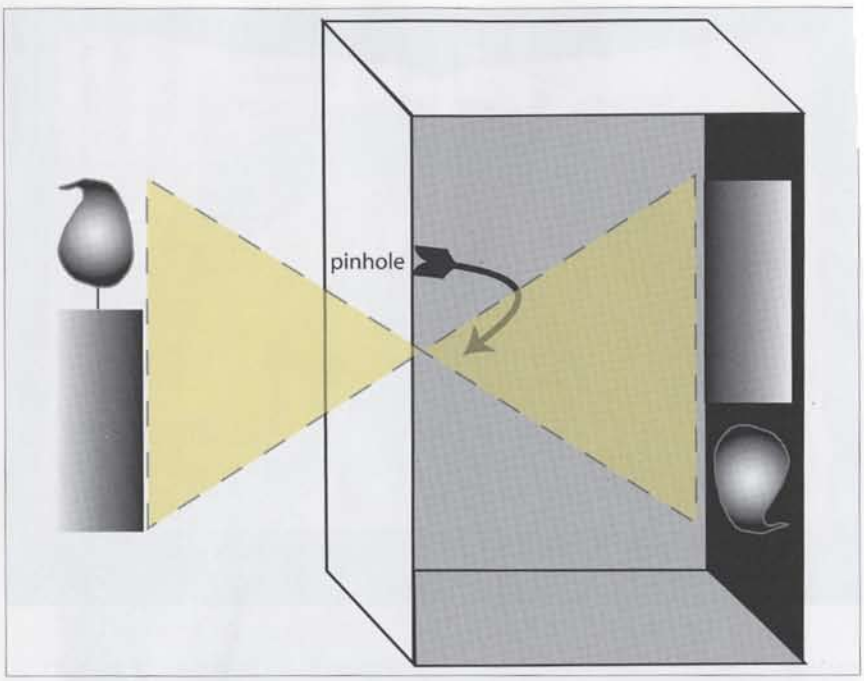
A variety of technological and artistic innovations occurring during the late 19th and early 20th centuries contributed to the eventual aesthetic development of digital imaging. These innovations included the development of moving pictures. But even before motion picture technology became the cinema as we know it today, Eadeward Muybridge (1830–1904) studied movement by capturing it in photographs. These sequential images are the ancestor of motion graphics in film and animation. **Figure 1-1** shows a photographic study by Muybridge of a moving horse. The series documented for the first time the actual placement of a running horse's legs, thus giving us information we never before could see with the unassisted eye. Later, the computer would make this kind of assistance to our vision an almost commonplace occurrence.



**1-1** *Eadeward Muybridge.* Galloping Horse. *1878. Silverprint.* Corbis.

## The Photographic Image

Early forms of photography included the camera obscura. It is a darkened box with a small opening that allows light rays to project onto the back of the box, forming a small, bright re-creation of an object outside the box. The history of the camera obscura is interesting. This process is very old, including projection rooms that were used as entertainment, as shown in **Figure 2-5.**




◆ **2-5** *A pinhole of light admitted into a darkened room or a darkened box will re-create an upside-down image of the world outside. A concept used for centuries, this is the premise of the pinhole camera.*

To experience this projection room effect, try going into a very dark room on a very bright day. Make a tiny hole in a window cover and look at the opposite wall. There will be the world outside the window, re-created fully in its color and movement. Why? Light travels in a straight line, and when rays pass through the tiny hole, they do not scatter but cross and reform. It is an optical effect that has been known for many centuries. Some contemporary photographers continue to be interested in this process and create small boxes called pinhole cameras. The outside world is exposed onto photographic paper placed inside the box.

Photographic innovators Niépce, Daguerre, and Talbot are credited with the invention of photography, as we know it. Joseph Niépce (1765–1833) produced a photographic image with a camera obscura onto pewter sheets, cleansed with oil. Louis-Jacques-Mandé Daguerre (late 18th century–1851) shared ideas with Niépce and went on to develop his Daguerreotype prints, which had remarkable clarity and detail. These silver-plated copper sheets went through various steps including exposure to mercury vapors, finally producing an image on the metal plate. Each Daguerreotype plate was a one-of-a-kind image.

William Henry Fox Talbot (1800–1877) developed a process that became the basis for the photograph and photographic printing plates. He developed negatives that could be used to make multiple images and photo-process printing plates. He also invented the photogram, a process in which light passes through an object placed onto a treated surface. When this surface is chemically treated, the image of the object appears. The previous chapter presented the creative work of 20th century photographer Man Ray, who used this technique.

Photographers to this point used a prepared wet plate before making the exposure. The plate had to be developed immediately afterward. George Eastman (1854–1932) introduced the Kodak camera in 1888 and eliminated this problem. Film could be exposed and then processed at a later time. Now ordinary people could readily record images and pose to have their own portraits recorded. By 1881 Frederick Ives (1856–1937) developed a method of etching lines onto glass creating **halftone** printing plates, and it became possible to reproduce photos on printing presses. The halftone was an image made of tiny dots that simulated a continuous tone. Graphic

designers need to be familiar with this process, and it will be discussed again later.

**The Implications** With the advent of photography, potentially anyone could create a "photo-real" image or have his or her portrait recorded. Portraiture was no longer the prerogative of the elite few. Perhaps more important, photography could document events, and it came to be viewed as a visual truth. Mathew Brady (1823–1896), a New York studio photographer, and his assistants recorded the American Civil War. **Figure 2-6,** by one of Brady's assistants, Timothy O'Sullivan (1840–1882), shows troop quarters dubbed Fort Hell. Such images changed the public's romantic vision of war by introducing them to the realities of battlefield suffering. We Americans experienced this again during the Vietnam War in the late 1960s and early 1970s as televised photography brought chilling truths about combat into American homes. Again, in Iraq, the prison abuse photos informed us in a way words never could.

Photography is still considered a form of visual truth. But as digital photography developed, manipulating the photographic "fact" came to be the norm.

◆ **2-6** *Timothy O'Sullivan.* Fort Hell. *1865. Silverprint photograph.* George Eastman House, Rochester, N.Y.

*Timothy O'Sullivan shot this documentary Civil War photograph of the quarters of men in Fort Sedgwick, also known as Fort Hell.*

## Early Innovations in Computer Graphics

As stated earlier, an integral member of the creative partnership is the tool itself. The previous section described conceptual innovations in the art world, while the next segment will describe innovations in the technological development of the computer. Contemporary digital images are created through a combination of the creative influences discussed earlier and techniques made possible through our New Media tools.

### The Moving Dot

Computers began as number crunchers in the 1940s around World War II. They functioned as powerful adding machines, performing millions of calculations at a speed never before imagined. Important as this invention was, everyone in the field of art and design would eventually be affected by the development of computer graphics at the Massachusetts Institute of Technology (MIT). It came in the form of a moving dot on the visual display terminal.

In 1953 the display of a moving dot had application in the defense industry. It could accurately show the track of an enemy bomber. This visual display's invention was funded by and created for defense, but innovations in computer graphics were quickly adapted in a wide variety of fields such as, but not limited to, medicine, architecture, and communication.

◆ **1-8** *Nam June Paik.* Piano Piece. *1993. Closed-circuit video sculpture, 120" × 84" × 48".* Albright-Knox Art Gallery, Buffalo, N.Y. Sarah Norton Goodyear Fund, 1993.

### Realism in Computer Graphics

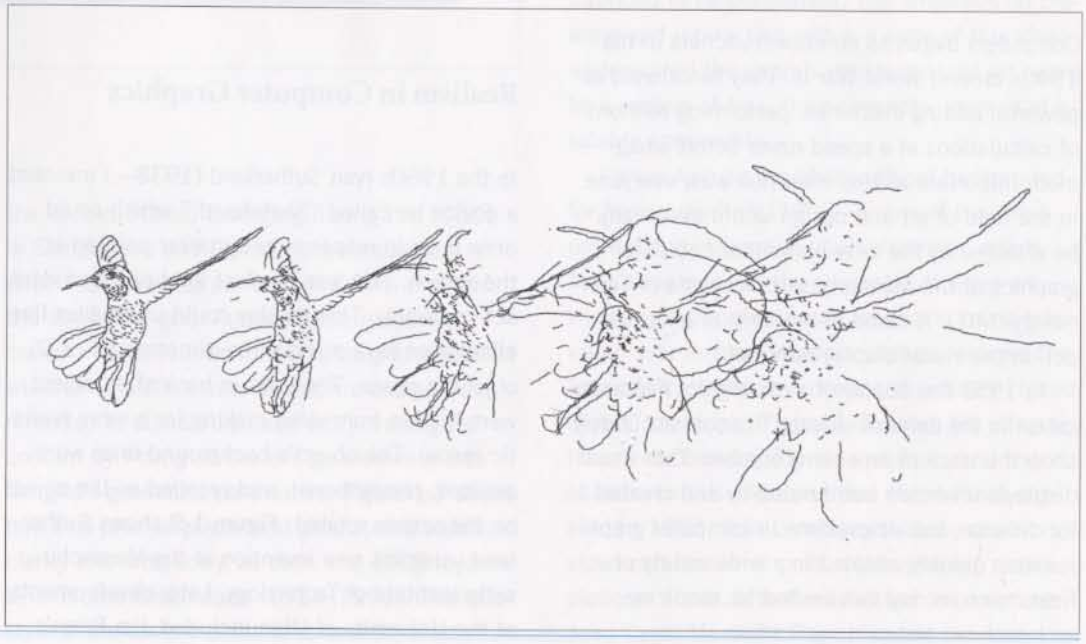
In the 1960s Ivan Sutherland (1938—) invented a device he called "Sketchpad," which could draw lines in response to a marker pointed at the screen. This was the first light pen and interactive display. This display could use **hidden line elimination** to depict a three-dimensional (3-D) object in space. The lines in back of an object were hidden from view, making for a more realistic model. The object's background lines were omitted, remembered, and recalled as the object on the screen rotated. **Figure 1-9** shows Sutherland using his new invention at the Massachusetts Institute of Technology. Later developments at the University of Utah included Jim Blinn's

**1-9** *Ivan Sutherland using the Sketchpad, a program for interactive computer graphics. 1963 photo of the artist dates from work at MIT in the 1960s.*
Courtesy, MIT Archives.

**wire frame drawing**. Highlights and surface textures were mapped onto wire frame drawings as both points and pixels combined to describe these new images. In 1974 Jim Blinn also developed reflectance and environmental mapping to make images even more realistic. Ivan Sutherland, his colleagues, and students also developed the digitizing tablet at the University of Utah during this time. Today, the modern digitizing tablet continues to allow us to draw with a pen instead of a mouse.

An important development in the early days of computer animation was the invention of **tweening**. Tweening allows the animator to omit several stages of the animation and to concentrate on creating key steps. The computer draws the in-between stages. During the 1970s, 3-D animation with **depth cueing** began to display the information in the background lighter than the images in the front to enhance the realism of the animations.

Professor Charles Csuri at the College of the Arts at Ohio State University was a pioneer in early computer graphics and animation. His innovative work began in the early 1960s. When Csuri decided to turn the computer into an artist's tool, the computer confronting him was a huge mainframe that required the entry of its data through punched cards. In 1967 his experimentation led to animated drawings, including one of a hummingbird in flight. Csuri produced over 14,000 frames, which exploded the bird, scattered it about, and reconstructed it. These frames were output to 16mm film. Three still frames from the resulting film *Hummingbird* are shown in **Figure 1-10**. The Museum of Modern Art purchased the film in 1968 for the permanent collection as representative of the first computer-



**1-10** *Charles Csuri.* Hummingbird. *1967. Still from computer animation.*
© Charles Csuri.

*This still from a ten-minute computer-animated film started as a series of line drawings. Computer-generated motion sequences were recorded by a micro-film plotter directly to film.*

animated artworks. Csuri is referred to as an Old Master in a new medium.

Computer graphics also became important in the medical community and was used to map DNA, creating simulations of the double helix. Previous medical models used sticks and balls to represent atoms, but computer graphics made it possible to simulate a moving 3-D image. With this imaging, researchers at California's Lawrence Livermore Laboratory became the first to use computer graphics to design new drugs.

The 1970s saw the development of Pong, the video game based on an interactive moving dot. It was the precursor of a huge leisure time and educational industry. Today's elaborate video gaming can be traced to Pong's interactive, bouncing ball. The last two decades of the 20th century saw an explosion of computer graphics across the art and design field, as well as in science and industry. The development of computer graphics contributed greatly to the 21st-century proliferation of computer technology in everyday life. Between digital phones, digital photography, and the ever-expanding Internet, many non-artists find computer graphics an indispensable part of their day.

## Desktop Development

The development of desktop computer graphics was an important part of the computer revolution. Just as the invention of the printing press and moveable type made the printed word accessible to a newly emerging middle class, thus encouraging literacy, desktop computers took computer graphics out of the domain of the scientific and technological elite. This egalitarian development is making clear the importance of *visual* literacy to all of us as we view or create digital images every day. Let's look at the origin of desktop computers.

Apple Computer introduced the first Macintosh in 1984. The screen presented a black-and-white visual display of pixels at a resolution of 72 ppi. Computer graphics became accessible to individual artists and designers, although the integration of type and image on the computer was difficult at this early stage. Interestingly, the first mouse was invented in the 1960s as part of a government research project. It became part of the Macintosh package.

In 1985 Aldus introduced PageMaker software for the Macintosh, and desktop publishing was born. Adobe Systems developed the PostScript programming language that enables printers to output a combination of text and images on a page. This made it possible for Apple to introduce a laser printer that used PostScript fonts. However, it would take some years for image processing and printing in the desktop environment to gain sophistication.

At the start of the desktop revolution, powerful image-processing programs were being used for advanced image generation and manipulation. Systems like the Quantel Paintbox and the Artronics Computer were referred to as "**paint systems**" and were stand-alone systems that contained their own software unique to the hardware packaged with it. These powerful machines were capable of delivering 16,000,000 colors and some color cycle animation in the 1980s, but few artists and designers outside of corporations and educational institutions had access to them. Very quickly, however, these machines were no longer necessary, as the desktop technology grew in sophistication.