Table of Contents

Introduction

Thesis Statement

From the moment animators realised that they could fool the brain into perceiving rapidly presented still pictures as movement, they have used and developed the best available technology to extend the illusion and to expand the boundaries of their art.

Overview

This thesis explores how the great schools of animation developed and how advances in computing have enabled the merging of different technologies to create a quantum leap in the techniques used to create animated films.

Chapter 1 describes briefly how animation originated. It considers the early technological advancements and their contributions and how they helped animated movies to become a recognised genre in its own right, enjoying worldwide success. It also considers the factors, including technological developments, which contributed to the growth of the Disney Studio, making it one of the most powerful names in animation, so much so that Disney and animation are almost synonymous.

Chapter 2 focuses on the advances of technology in the late 20th Century, with the industry essentially leaving the original world of traditional cell animation in the background and moving on to the growing field of Computer Generated (CG) animation. It illustrates this with examples of developments by the Disney Studio and its collaborator, PIXAR, in their films *Toy Story, A Bugs Life, Toy Story 2, etc.* It shows how Computer Generated Animation is a development of traditional technology, using the availability of computing power (a) to generate images that would otherwise be drawn by hand or machine and (b) to make the results realistic in a way that drawings could never achieve.

Chapter 3 looks at the future of animation and at the convergence of technologies from the film industry and from computer games. It demonstrates how one particular convergence is giving rise to a completely new type of animation called *Machinima* (standing for machine-animation-cinema) where an animator uses a computer game engine to develop the animation rather than using conventional forms of CG animation. It discusses the possibilities that this new technique offers for the everyday creation of animated movies.

The concluding page explains why *Machinima* will have a valid and continuing role in the development of the animation industry.

Chapter 1

THE ORIGINS OF ANIMATION

Persistence of Vision

To 'animate' literally means 'to give life to'. 'Animating' is moving something which cannot move itself.[1]

Of course, animation in the film sense does not literally give life to an inanimate object; it merely creates the illusion of life by creating another illusion, that of motion. Motion pictures, i.e., movies, cartoons and videos, all depend for their effects on fooling the brain by passing a number of still images in front of the eye at a fast enough rate it will create the sensation of continuous movement.

The receptors in the eye continually sample light in the environment. The only limitation on motion detection is the reaction time of those sensors and on certain mechanical limitations such as blinking and tracking. If an object moves fast enough, then the receptors in the eye will not be able to respond fast enough for the brain to distinguish a sharply defined, individual detail; motion blur results.[2]

The effect being exploited is known as persistence of vision, which was first demonstrated in 1828 by a Frenchman, Paul Roget, who invented the *thaumatrope.* The brain retains a visual image (now known as *afterimage*) for a fraction of a second after one image is removed. Then, when a second image is placed quickly in front of the eye, the brain can retain the first afterimage and mix it with the new image. Although we do not recognise the

---

[1] Rick Parent, Computer Animation: Algorithms and Techniques, Introduction to Computer Animation. (Morgan-Kaufmann, 2001). Chapter 1
[2] **Ibid**, Chapter 1.2 Perception

images as individual photographs, we do notice the differences between them. The brain then perceives these differences as motion.

In film and video, a sequence of images is recorded which can be played back at rates fast enough to fool the brain into interpreting them as continuous motion. The crucial rate of *frames per second* (fps - the number of images needed to produce one second of film) is 24 fps. This rate is the lowest possible rate that will fool the brain into perceiving the series of still images as continuous motion. Anything slower will appear jerky and not continuous. A faster rate is a waste of resources as the brain will notice little enhancement in the movement. In animation, the artist is able to save further on resources, while still maintaining the persistence of motion, by using a method of *twos* or *threes*, where the same frame is repeated two or three times rather than using a different drawing for each frame. This does, of course, take away slightly from the smooth quality of the animation, but is essential to the commercial production of animations.

Early Years

The discovery of persistence of vision led to the development of technology and experimentation with motion-picture devices throughout the 19th century. Among the first devices developed was the *Zoetrope* in the 1830's, or "wheel of life". The Zoetrope was a hollow drum with a series of pictures around its inner surface, and slits cut down through the drum to look into. When spun, it produced the effect of motion in the individual drawings on the inner surface of the drum. In the 1870's, the French inventor Émile Reynaud improved on this idea by placing mirrors at the centre of the drum, giving a more seamless illusion. A few years later, he developed a projecting version, using a reflector and a lens to enlarge the moving images.

A low-tech piece of animation equipment was the flipbook was also commercialised in the 19th century. The flipbook is a tablet of paper with a slightly different individual drawing on each page. When the viewer flips the pages over quickly, the images appear to be animated.

With advances being made at the same time in the field of photography, further developments of the idea of animating still photographic images became possible. Possibly the most famous experiment and development was in the 1870's. To win a bet, the railroad tycoon Leland Stanford hired British photographer Edward Muybridge to photograph a horse as it ran at full gallop, to establish if a horse had all four feet off the ground at any one time. To do this, Muybridge set up 12 cameras along a racetrack and spread threads across the track with a contact to each camera's shutter. Moving along the track, the horse broke the threads and caused a sequence of photographs to be taken. The photos showed the horse with all four feet off the ground, and Muybridge went on a lecture tour showing his photographs on a moving-image device he called the zoopraxiscope.[3]

These early forms of animation were used initially to entertain audiences – "still unsophisticated as far as motion pictures were concerned ….. A drawing that moved seemed even more magical than the images derived from life ….."[4]

John Bray's work and patents in 1910 are good examples of how technology influenced traditional animation. Bray came up with the idea of drawing on translucent celluloid paper so that his pictures were not then limited to a plain background. The breakthrough in the field of animation came from using multiple layers of the translucent celluloid images or *cells* (from celluloid) in the final image. Animators could then break each frame into foreground, mid-ground, background and character action. Each scene could now have

---

[3] "Motion Pictures, History of," Microsoft® Encarta® Online Encyclopaedia 2004 http://encarta.msn.com © 1997-2004 Microsoft Corporation.
[4] Manvell, Roger. Art & Animation: The Story of Halas & Batchelor Animation Studio 1940/1980. (New York, Hasting's House, 1980). Chapter I

one background and the action could be drawn on a series of cells to be laid on top of the background. This development saved huge amounts of time and production costs for each film. Later developments of this technology added holes for pegs on top of the sheets for registration, and the drawing of the background on long sheets of paper so that panning could be performed more easily. Artists in Bray's studio were the likes of Max Fleischer, creator of *Betty Boop*, and Walter Lantz, creator of *Woody Woodpecker*.

Animation's Disney Years

"There is no particular mystery in animation...it's really very simple, and like anything that is simple, it is about the hardest thing in the world to do."

- Bill Tytla of Walt Disney Studio's, June 28, 1937- [5]

For most of animation's history, cell animation has been the industry standard, largely due to the influence of one studio, originally known as *The Walt Disney Company*. Walt Disney, the company's founder, was the overpowering force in the history of animation. Not only did his studio contribute several technical innovations, but the Walt Disney Studios, more than any other company, advanced animation as an art form.

Walter (Walt) Elias Disney, was born in Chicago, Illinois on 5th December 1901, but grew up in Kansas City, Missouri, where he met animator Ub Iwerks and composer Carl Stalling, who were to be important to his future success. Disney began animating films in Kansas City, then moved to Hollywood, California in 1923 to produce animation motion pictures, one of which was *Alice Comedies*.

From 1926 to 1928 Disney produced a cartoon series, *Oswald the Rabbit*, for Universal Pictures. After losing the rights to his *Oswald the Rabbit* series, Disney (with his then-partner, Iwerks) created a character that was to become the most famous animated figure in history: Mickey Mouse. Mickey Mouse

[5] Computer Animation, Traditional Film Camera Techniques. (2000)

made his debut in *Steamboat Willie* (1928), which includes a musical score by Stalling and was Disney's first sound film. The Mickey Mouse series of short films gradually incorporated a number of other popular characters and ran for several years.

Disney's main contribution to animation was to develop it as an art. He perfected the art of communicating to the audience the different personalities of his characters, including Mickey Mouse, Pluto, Goofy, the Three Little Pigs, and the Seven Dwarfs. He also promoted the idea that the mind of the character was the driving force of the action and that a key to believable animated motion was the analysis of real life motion. Disney gave characters further depth by extending cartoons to feature-length, as in *Snow White and the Seven Dwarfs* (1937), followed by other feature-length films, such as *Pinocchio* (1940) and *Bambi* (1942).

On the technology side, the use of sound for the first time in *Steamboat Willie* (1928), synchronising the movement of the characters to their voices was a technological leap which developed the believability of the characters. Disney also produced during the 1930s the Silly Symphony series of shorts which served as vehicles for experimentation with new technologies, e.g., Technicolor, an important early colour film system. He first used colour in the Silly Symphony film, *Flowers and Trees* (1932), which became the first cartoon to receive an award from the Academy of Motion Picture Arts and Sciences[6]. In exploring the relationship between visuals and music, the Silly Symphony shorts can be considered precursors of Disney's full-length animated film *Fantasia* (1940), where short animations were played as interpretations of well-known symphony music, recorded and played in stereo sound – another first.

Production lines had come into American industry with the manufacture of the motor car and Disney brought production-line techniques to the creation of animated films. He thus kept productivity high and costs low. One

[6] Bryman, Alan. Disney and his Worlds. (London, New York, Routledge, 1995). Pg 8

Disney innovation was the use of storyboarding to plan and review the story, setting up the whole production sequence in advance. A storyboard is now the standard in all film making, not just in animation. Disney also used pencil sketches to review motion before the final cells were inked. He also invented the multi-plane camera stand which allows the character layer, foreground layer, mid-ground and background to be positioned at different distances from the lens and to be moved at different rates. Each of the planes can move six directions (right, left, up, down, in, out) and the camera can move in and out as well. Thus, as the camera pans across the scene, an illusion of depth and zooming can be created.

Chapter 2

THE ADVENT OF COMPUTER ANIMATION

Computer Generated Images

Notwithstanding its technological innovations, Disney animation remained in the mode of classical animation. The artists created a succession of cartoon frames, which were then combined into a film. Other animators, using physical models instead of drawings have also produced very interesting work. In this so-called *Stop Motion* animation, the animator constructs and positions models, records an image, moves the model to its next position, records the next image, and the process continues. Excellent films, e.g. *King Kong* (1933) and *Chicken Run* (2000) have been made by this method. Nevertheless, the process is still one of photographing still images and projecting them at a speed of 24 frames per second.

The development of computer animation began to change fundamentally how the images in an animated film were generated. There are two main categories of computer animation: *computer-assisted animation* and *computer-generated animation*. Computer-assisted animation usually refers to 2 dimensional (2D) and 2½ dimensional (2½D) systems that computerize the traditional hand-drawn animation process. These systems are essentially tools to facilitate traditional processes. The end result is still a series of still images that will be photographed and then projected.

On the other hand, computer-generated animation, known as CG animation or CGI (*computer-generated images)*, generates the images electronically in what can only be described as a virtual studio. The animated images do not exist as paper or celluloid images that must be photographed, but rather as electronic digital code. And in that form they remain, until the final product is rendered into a series of high quality electronic images before being committed to film for distribution. Increasingly, distribution will be by transmitting images, or even entire films, as streams of digital data. In the future, animations, although apparently still in the classical tradition, will never have had an existence as a series of physical images.

An early an influential system was developed in 1963 by Ivan Sutherland who created *Sketchpad* for his PhD thesis. *Sketchpad* consisted of a Cathode Ray Tube (CRT) display, a lightpen, and a bank of switches to create the first Graphical User Interface (GUI), although that term had not yet been coined. He could use the lightpen together with the CRT to create, manipulate and store highly precise drawings. The software provided a scale of 2000:1, offering very large drawing spaces. *Sketchpad* pioneered the concepts of graphical computing, including memory structures to store objects, rubber-banding of lines, the ability to zoom in and out on the display, and the ability to make perfect lines, corners, and joints. The possibility of storing images to be played back in sequence later enabled animated drawings to be displayed on the screen. The main limitations of *Sketchpad* were its limited recognition capabilities, limited storage and the high cost of the computer used. However, it was the starting block of computer-generated animation as we know it.

An early analogue animation computer was the *Scanimate*, developed from 1969 onwards by Lee Harrison III, founder of Computer Image, in Denver, Colorado. The *Scanimate* process started with backlit light tables, onto which high-contrast artwork was mounted. These were scanned by a progressive scan monochrome camera. This image was displayed on a five inch precision monochrome CRT and the picture was manipulated by adjusting voltages from an attached analogue computer using knobs or switches to activate programmed signals. The operator acted like the conductor of an electronic orchestra, constantly adjusting knobs and dials to achieve the desired effect while the animation was running. One of the most famous *Scanimate*-generated film sequences was the brief false-colour image of the Death Star emerging from behind a planet in the first Star Wars film (*Star Wars*, 1977).

A major part of making animation believable is motion control. Early CG animation systems did not have the computational power to allow for animation preview and interactive control. Also, many early animators were computer scientists rather than artists. Their systems were used to enter data, or to visualise simple objects and were not regarded as contributing to an art form.

As analogue computers gave way to digital machines programming became easier and programs more widely available. Digital computer animation has now developed to the extent that sufficient computation power and readily available software (*3-D Studio Max, Maya and Lightwave*) enables the animator to create a virtual 3-Dimensional space and to move objects around it at will. For a simple animation, the artist might just move the object around the environment or change a camera angle. More sophisticated use of computer animation allows him to move the camera and/or the objects in more interesting ways, e.g. along computed curved paths.

Computer Animation in Film and Video

Artistically, Computer Graphics can be used either as distinct and recognisable special effects in a film, or they can be integrated with live action, or they can be used to make a film in its entirety.

Early on, Computer Graphics (CG) appeared in a variety of movies in which it was not intended to fool the audience into thinking it was anything other than CG, partly because the technology to do so was unavailable. For example, in *Star Wars* (1977), the CG images create a science fiction setting that would have been impossible to create using filmed sets[7]. *Tron* (1982), however, was different. Because the story is set in a computer game inside a

[7] Manvell, Roger. **Op.cit**. Chapter II

computer, the computer graphics in the movie were still supposed to be computer-like. The CG imagery was used throughout the movie, as part of the action and as part of the storyline. The film integrated computer animation with live action, but, since the action took place in a computer, the CG didn't have to look realistic. This was the first time CG was used as an integral part of a movie.

CG is also used to create 'alien' creatures, i.e., creatures that are supposed to be realistic, but which do not match anything with which the audience is familiar. *The Abyss* (1989) is one such movie in which CG is used to create an ‘alien’ creature which is integrated with the rest of the live action.

CG is also used to suspend disbelief, as in creating an illusion of stopping time. Interestingly, Edward Muybridge’s original idea of using still cameras to capture individual elements of motion was updated with modern technology to generate the groundbreaking special effects of ‘bullet time’ in *The Matrix* (1999). In this film, the special effects team set up a series of still image cameras in a long sequence a single degree apart around the set (Figure 1). They then shot individual pictures in sequence along the series of cameras at film frame rate (24 frames per second), creating the illusion of a slow motion panoramic shot. The path of the bullet was created by generating a graphic for each frame of film (Figure 2).

Figure 1 - Set up of cameras for ‘Bullet Time’

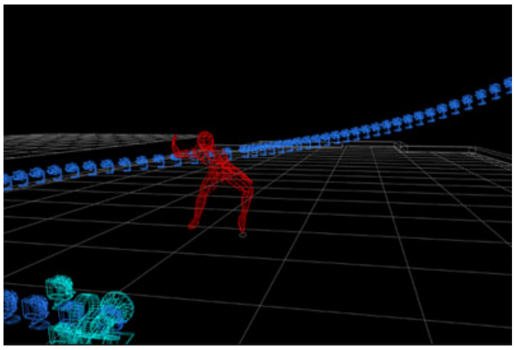

Figure 2 – Computer Generated Visualisation of ‘Bullet Time’

PIXAR – Disney's Computer Animation Years

"*A computer is like a pencil. It is a really amazing pencil. [But] computers don't create computer animation any more than a pencil would create a drawing*."

- John Lasseter, Executive Vice President of PIXAR -

The Holy Grail of computer generated animation is, of course, to use the technology to produce full-length animated pieces which would otherwise be done by more traditional means - essentially 3D cartoons. The company that achieved this milestone is PIXAR.

PIXAR had its origins in 1984 when John Lasseter left his animation job in Disney to join George Lucas's special effects computer group. This special effects group was later to become PIXAR. It was also in the same year that John Lasseter made his first 3D animated short, *Andre and Wally B* (See Figures 3, 4), which premiered at SIGGRAPH (a convention focusing on research, art, animation, games, interactivity, and web graphics). *Andre and Wally B* was very limited because at the time only geometric shapes could be animated. Lasseter pushed CG animation further by asking for a tear drop shape that could be bent and manipulated.

Figure 3 – Cartoon drawing of Andre

Figure 4 – The closest a Computer Generated Image could get to Andre

In 1986, Apple's Steve Jobs purchased the graphics division of LucasFilms and established PIXAR as an independent company. That same year, PIXAR produced its first short, *Luxo Jr.* It too had its world premiere at SIGGRAPH and later went on to win an Academy Award nomination in 1987 for best animated short film. In the subsequent years PIXAR developed a series of short films and commercials, continuing its growing success. Up to 1995, PIXAR had created over 41 commercials, and developed its own rendering software.

PIXAR has created five of the most successful and beloved animated films of all time: the Academy Award-winning *Toy Story* (1995); *A Bug's Life* (1998); *Toy Story 2* (1999); the Academy Award-winning *Monsters, Inc*. (2001); and finally *Finding Nemo* (2003). PIXAR can almost be regarded as the Disney Studio's computer animation arm since its 1991 agreement with the studio to develop and produce computer-animated feature length movies.

It was under this agreement that *Toy Story* was developed, produced, and distributed. *Toy Story* created history in being the first fully computer-animated feature film. The film received tremendous critical acclaim and became the highest grossing film of 1995, generating over $360 million in worldwide box office revenues.

In 1997 PIXAR entered into the Co-Production Agreement with Disney which replaced the original Feature Film Agreement. The first two original Pictures under the Co-Production Agreement were *A Bug's Life* (1998) and *Monsters, Inc* (2001). Most recently, PIXAR's fifth film *Finding Nemo* (2003) smashed box office records all over the world. It opened domestically in the United States with an intake of $70 million over the first three days. The highly anticipated new feature *The Incredibles,* from director Brad Bird (director of *The Iron Giant*) is set to break even more records.

Technology

As well as being artistically successful, PIXAR is a technology-driven company. Its success today is underpinned by its technological foundations. It has been responsible for many of the important technological breakthroughs in the application of computer graphics to film making. PIXAR developed several software programs that made *Toy Story* and its other animations possible.

The first was *Menv* or Modelling Environment which took nine years to develop. *Menv* animation tool was used to create 3-D computer models of characters with built-in animation controls, allowing the artist to articulate the characters through specific frames of an animation. This tool eliminates the need for frame-by-frame animation, like that of cell animation, making the motion much more fluent and believable. This then was developed further to become Marionette™, an animation software system for modelling, animating and lighting,

RenderMan11® is a rendering software system which puts together complete digital information for a 3-D animated scene - colour, shading and lighting - and renders it onto each frame for high-quality, photo-realistic image synthesis. PIXAR uses the program internally and licenses it to third parties. It is possibly PIXAR's most significant program and is now the industry standard rendering software.[8]

The technical developments at PIXAR, needed to successfully create *Toy Story*, have given other animation studios the opportunity and ability to create the same effects for their movies. PIXAR's RenderMan technology was used in:

- Jim Cameron's *The Abyss* for the creation of the water creature.
- The T1000 character in *Terminator 2*.
- The dinosaurs in Steven Spielberg's *Jurassic Park*.

[8] The Renderman Companion. (Addison Wesley, 1990). Chapter 3.

Chapter 3

THE FUTURE

What Lies Ahead

Two trends in the animation industry are likely to have a profound influence on its future:

> the significant increase in publicity, recognition and exhibition opportunities that animation is now receiving; and
>
> the growing importance of new technologies and the availability of the tools to the public, allowing people to make their own animations at home.

For many years, animation festivals have been the showcases of the best non-feature/mainstream films. Association Internationale du Film d'Animation (ASIFA) has screened short works from a wide variety of mostly independent (non-commercial) animators. During the mid-1980s, a number of American travelling animation festivals - such as the *Spike 'n' Mike* series and Expanded Entertainment's *Tournee of Animation* - brought prize-winning films to smaller communities and quickly developed a loyal following in the United States. ACM’s SIGGRAPH is a film festival focusing on research, art, animation, games, interactivity, and web graphics, and holds a three day exhibition for graphics and interactive media. Some of the greatest animators have been involved, including John Lasseter, as mentioned earlier.

In the United Kingdom, both Channel 4 and the British Broadcasting Company (BBC) have supported the production and broadcast of innovative animation. In the United States, cable channels Cartoon Network and Nickelodeon have developed animated series. Animators at all levels have created online animations that are freely available over the World Wide Web. The festivals, commissions from television and film companies and interest on the World Wide Web combine to create a market for animators.

Computer-generated animation has made a significant impact on the animation industry. In recent years, computer-generated animation has focused a great deal of attention on creating realistic-looking human figures, as well as fire, water, fur, natural environments, all challenging tasks. It is unlikely, however, that other animation techniques will fade completely. As in the past, independent animators will continue to create innovative personal expressions using a variety of approaches, developing new methods and expanding the definition of animation as an art form.

The falling cost of equipment has allowed people to create high end animations from their own home computers. Computers are continually becoming more powerful, and much cheaper. Each new generation computer that is released is twice as powerful as its predecessor. As computers are getting cheaper, smaller and more powerful, the limits of computer development are expanding all the time.[9]

[9] Computer Graphics Hardware Overview. Display Devices. (1999).

Machinima

"Introducing the revolutionary real-time unreality that is Machinima: shooting film in virtual reality."

-Machinima.com-

The converging trends of an available market and low cost equipment have enabled the growth of new technologies from home-based pastimes. One such development is a new technique of animation, called Machinima which is now a genre of its own within animation. Machinima (Ma-sheen-EH-ma) is the fusion of "machine", "animation", and "cinema". Essentially it is the creation of film in the 3-Dimensional virtual environment of a computer game.

Machinima uses graphical techniques originally developed for computer games to generate its visuals. It allows a film-maker with a home PC (Personal Computer) to create feature-length epics that would require millions of dollars to make using traditional CGI (Computer Generated Imagery) techniques, thanks to the fact that the Machinima film-maker can make his or her film in real time, rather than painstakingly animating it frame by frame.[10]

The idea behind Machinima arose in the mid to late 90's when computer game players began to record video files of games, or demonstrations of tricks and tips in games, to be shown to other players. These video files were then passed around from player to player, showing the game player's skill. Some of these videos were recorded at events such as E3 (Electronic Entertainment Exhibition), a computer game convention featuring new games and competitions. The videos could be edited and could, for example, be quicker paced, or have music added.

---

[10] What is Machinima? (Machinima.com, 2001).

Today's game "*engines*", i.e., the code or instructions underlying a game, make ideal virtual sets. Already pre-defined in them are numbers of sets, various characters, the physical laws of the environment in which they are set and the outline of a plot.

The codes for the major games are open source and are intended to keep gamers interested in the game by facilitating the development of new games, or levels in a game. Using the source code, a gamer can also create modifications (commonly known as 'mods') to games. 'Mods' have been created either by the computer company that published the game, or by interested gamers, and are downloadable from the Internet. It did not take gamers long to realise that the use of 'mods' allowed games to be further changed to tell stories of the gamers' own invention. In this way, creative gamers became *Machinimists.*

'Mods' allow the characters in the games to look different from those predefined in the original computer game. Thus, by giving a character a new 'skin' or body shape, the Machinimist can create a new character. Other 'mods' allow the characters to be placed in different environments and locations. These create virtual sets for the action. Further 'mods' manipulated the predefined laws of physics of the game; allowing faster speed, lighter gravity, larger explosions, etc., freeing the director to use his creativity at will.

The leading games that have been used to develop Machinima films are *Quake II*, *Quake III* (Id Software), *Halo* (Microsoft), *Half-Life* (Valve). The 'mods' for the *Quake III* game, for example, include:

> *Matrix*-like developments where 'bullet time' can be recreated and characters can run across walls;
> an *excessive* 'mod' that allows explosions to be over-exaggerated; and

a *Rocket Arena III* ‘mod’ where players take no self-inflicted damage.

To the Machinimist, these ‘mods’ are the equivalent of manipulating the physical laws of the environment in which the computer-generated animation is set.

Another modification of *Quake III* is called *Urban Terror*. It is a tactical-based ‘mod’ which manipulates not just the environment of the game, but also how it is played. For the machinimist, using it is the equivalent of being able change the story line, the sets and the characters of the movie.

Once the Machinimist has set up his virtual set, decided on the physics of the environment, defined the characters and outlined the story, he can proceed to shoot the Machinima animated film in real time. Using a computer network, each character in the movie is controlled by a computer gamer in the same manner as he would control a character if he were playing a computer game. The difference is that, in Machinima, the gamer is following a script and the movements of the characters are being recorded.

The computer games on which Machinima is based are so-called *first person shooters* (FPS). In these games, the player sees the virtual world through his own eyes, i.e., from a first person point of view, hence the name. In a Machinima movie, the player becomes a camera. Some players will be invisible and are the equivalent of an unseen camera recording the action. They can be thought of as ghosts that can move around the environment as only ghosts can, i.e., through walls, up and down with no gravity, etc. Other players will be visible and will take part in the action. The computer records what each visible or invisible player sees, providing a variety of camera angles for post-recording editing.

Capturing real time animation in a virtual environment allows the Machinimist to behave more like the director of a live-action film, rather than an animator. He can manipulate camera angles by directing how many invisible players (i.e., cameras) are to be used and where they are to be positioned; he can change the '*field of vision*' (the width of the field that the camera sees) of any camera by a simple change of code[11]; and he can re-shoot scenes until they are to his liking. Machinima thus combines the advantages of live-action and animation.

Machinima has further advantages in post-recording editing. Any scene that is not correct can easily be re-shot by having gamers re-enact the scene. As the environment is a computer-generated virtual world, there are no issues of matching the look of different parts of footage.

A creative benefit of Machinima is that the director can have as many cameras or actors as he wants. He is limited only by access to server space and the required number of PCs. Collaboration is also made easier as the gamers who control the characters in the Machinima film are cooperating in a virtual environment over a computer network. With the development of broadband access to the Internet, collaboration across borders is possible, with gamers from different countries working on a single movie without ever having to leave home. Not only is collaboration possible, but it is cheap: travel times and costs are eliminated as the cast meets in virtual cyberspace.

Shooting Machinima in real time also eliminates the slow arduous process of rendering the images; what appears on a player's monitor is what is recorded for that player. This process does, admittedly, take away from the quality of the final product as game images are not yet of the high quality of 3D images rendered by powerful commercial software.

---

[11] Computer Animation, Traditional Film Camera Techniques. (February 08, 2000)

Machinima Today

Machinima animated films are not yet mainstream. However, a number of cult films have already been made and are available on the Internet. The Machinima community also have a film festival and award ceremony, the Machinima Film Festival with awards in the following categories:

- Best Acting
- Best Sound
- Best Picture
- Best Editing
- Best Writing
- Best Direction
- Best Visual Design
- Best Independent Film Effort

At least one commercial music video has been made using the technology.

Figure 5 – Screenshot from *Red versus Blue*

Of the movies, *Red versus Blue - The Blood Gulch Chronicles* is a satirical dialogue-driven show created completely by Machinima in the virtual world of Microsoft's game *Halo*. Technically, *Red versus Blue* does not change the characters or the settings given in the game *Halo*. It even uses the colours of the original characters (hence the name, see Figure 5) and it actually incorporates the original *Halo* story into the film. It was sufficiently original, however, to be the winner of the Best Independent Machinima Film, Best Writing, and Best Picture at the 2003 Machinima Awards.

The Machinima production company, Ill Clan, took a different approach in making the music video for the song, *In the Waiting Line*, recorded by *Zero 7*. Ill Clan used the *Quake* III engine for the video. However, it changed the appearance of the character, so that it now appears as a robot. It also altered the environment from a dark, rough landscape to a bright and smooth location that better suits the song (as can be seen in Figure 6). The music video was aired frequently and became the first music video ever to be created by Machinima. It won Best Commercial/Game Machinima, Best Visual Design, and Best Direction at the 2003 Machinima Awards.

Figure 6 – A scene from "In The Waiting Line" by Zero 7

The director of the animation, Tommy Pallotta, had previously used rotoscoping in earlier projects such as *Waking Life* (2001), *Figures of Speech* (2000), and Zero 7's earlier video, *Destiny (2001)*.

He explained why he rejected traditional animation and film techniques and turned to Machinima:

> It's important to work outside of a comfort zone, in order to test out new ideas… Game engines presented a new challenge. On one hand, they allowed our team incredible flexibility. We could change lighting, camera angles, and textures on the fly, in real-time, rather than waiting overnight for the data to render. On the other hand, we were using the engines to do something that they were not originally designed to do. We spent a lot of time tweaking the code, making changes that would allow us to bring film language into a gaming environment.[12]

As a director, Pallotta depended on combining the film experience of Fountainhead Entertainment with the Machinima expertise of Ill Clan, to work on the Machinimation; to move the character around in the virtual environment; to import models and animations as props; to create cameras to record the action; and finally, to render out the frames of the animation.

It is this freedom to be able to tweak the code that has allowed Machinima to develop. However, it is not just the tweaking of the code that allows Machinima to thrive, but also advances in the engines themselves. The computer game engines have undergone massive changes. Initially in the *Quake* engine, each character had to hold a weapon but, with development, that requirement was worked around and characters could be modelled empty handed. The latest game engines can produce reflections, and shadows (using dynamic lighting). In earlier games shadows were mere darker spots on the floor, but have now become sophisticated silhouettes of the model, directly affected by the surrounding light. Older engines could not even render a reflection of a character, but now reflections, and images of see-through glass materials can be rendered.

In the standard setup of the *Quake III* game engine, many of the parameters are variable: the quality of the screen can be sized up to 2048x1536 pixels, which would look fine on a cinema screen, and has the function of 856x480

[12] "Zero 7's "In the Waiting Line"" MVWIRE.com. 2003.

pixels allowing widescreen viewing; colour can run at 32bit; and geometric detail, texture detail, texture quality, brightness, etc. can all be changed. All of this is possible, without even going into the game's source code to change anything. The quality now available already surpasses the quality of the early animations done in CG.

Machinima has already made companies so enthusiastic that the new genre has an annual Machinima Film Festival, featuring the best Machinima. In 2002, the award for best film went to Jake Hughes, an animator employed by the game maker Crystal Dynamics, for his dark science fiction thriller *Anachronox* (Edios Interactive and Ion Storm).

Anachronox started off as a game release, a turn-based, third-person perspective, party-based RPG (role playing game) using the *Quake 2* engine. The original in-game cut scenes (short snippets of animated cinema that are edited into the game between levels to develop the story or the character or game) were then developed into a Machinima film. Cut-scenes are usually created using traditional computer-generated animation, as they will be shown in a much higher quality. However, for *Anachronox*, director Jake Hughes used the game engine to generate the scenes (example in Figure 7). As Hughes said[13]:

> But we didn't want to take a player out of the game and show a movie where the characters look different … so we just do it in the game engine. We have a beautiful game engine so why not use it?

In developing the games, Hughes realised that he had a substantial body of work in the cut-scenes. Hughes said

> When added up, the total running time of the cut scenes came to 2 hours and 30 minutes, so I thought it might be fun to string them together and see if it would work as a straight narrative.

[13] Bieve, Celeste. "The animation game, Technology." The New Scientist, Vol. 180, No. 2418, October 2003, pp 28-31.

Thus was the Machinima, *Anachronox* created. The cut-scenes from the game all appear in the film, although some cuts and edits were made for continuity and story-telling purposes.[14]

Figure 7 – Screenshot from *Anachronox*, displaying the use of dynamic lighting

Interestingly, Hughes noted that

> "The game wasn't a success. We worked very hard. Then to get recognized at the Machinima Awards... It was one of the proudest moments of my life."

An excellent example of the development of Machinima comes from the production company, *Strange Company*. Its series, *Matrix 4x1* (2000), comprises four short films inspired by the characters and settings of the Warner Brothers movie, *The Matrix*. Written and directed by Hugh Hancock, *Matrix 4x1* has become one of the most popular Machinima films

[14] Rouse, Richard. "Embrace Your Limitations — Cut-Scenes in Computer Games", ACM SIGGRAPH, Vol.32 No.4, November 1998.

ever, having been viewed over 100,000 [15] times since the release of the first episode, *The Control Room*.

Originally made as a corporate training video for an event with a "*Matrix*" theme, the films were made in less than one month using a combination of Valve Software's *Half-Life* game, scripting technology and live "action" within the game.

Figure 8 – Screenshot taken from *Matrix 4x1* (Control Room)

Matrix 4x1[16] displays the versatility of Machinima technique using only the in-built cinematic and scripting tools of a game (*Half-Life)*. The episodes were shot from standard first-person or spectator (camera) point of view (Figure 8). However, one sequence, the "*Bullet Time*" sequence in the *Control Room* episode was created using *Half-Life's* chase cam routine, where the camera is locked onto a character's movement (Figure 9). This allowed the director to replicate the 'Bullet Time' special effect from the original Matrix movie with a simple swipe of a computer mouse.

[15] "Ask strange Company: Part 1", Machinima.com, 2001.
[16] About Matrix 4x1. Cybernetic Productions. (Strange Company.com, 2000).

Figure 9 - Screenshot taken from *Matrix 4x1* in a chase cam sequence (Control Room)

The *Matrix: 4x1* series stands as one of the best examples of Machinima's potential for high action on low budget. The producer of the series, Paul Flanagan from the training company, Cybernetic Productions, said:

> We were looking for a cinematic experience for our event, and we knew that there was no way we could fill that demand in the time with any conventional film techniques… When we heard about Machinima for the first time, it was a real revelation - and the results were fantastic.

Future Directions

Not everyone in the animation community shares this benign view of Machinima. Mark Behm, an animator at Blue Sky Studios in White Plains, New York says:

> I can see a real use for real-time playback in some cases. But I think the point many miss is what one gives up. Not just the pretty picture, but the power, the emotion, the richness, warmth and believability of the film. As far as being a threat, I don't see one at this time. PIXAR, and many others, probably could make films at

> half the cost, but aren't willing to give up what they would lose if they did[17].

Tom Sito, President Emeritus of the Hollywood Animation Guild agrees, saying:

> When will people understand it is not about the cost? When will the science community understand that real time performance-based animation will never replace traditional methods? [18]

However, traditional animators voiced similar sceptical thoughts when CG animation was developing. Now CG dominates the animation market.

Machinima programmes themselves are advancing with developments in technology and the other point of view is put by Gabe Newell, from the game company, *Valve Software*:

> Machinima is primitive, but unlike movies it is on a technology curve. Next year Machinima will be twice as rich and the year after traditional movies will look pretty grainy ….[19]

At the moment, the quality of Machinima is nowhere near that of fully-rendered CG animations, especially in terms of reflection from, and refraction, in water or glass such as made *Toy Story* or *Monsters Inc*, so beautiful. Computer game engines run on calculations from quick algorithms that are rendered in real time of 24 frames per second, whereas for movies such as *Toy Story*, it could take hours to render a single frame. Nevertheless, fast progress is being made and the quality of Machinima movies is improving rapidly. Animations are becoming smoother and of a higher quality. Comparing the early forms of Machinima, based on the *Quake* engine, to *Red vs. Blue*, which is a simple use of the Microsoft's *Halo* engine, the differences are stunning. Bill Rehbock of NVIDIA, a graphics card company, noted in the New Scientist:

---

[17] Bieve, Celeste. **Op.cit.** pp 28-31.
[18] **Ibid.** pp 28-31.
[19] **Ibid.** pp 28-31.

> Games used to be blurry – they weren't ready for prime-time TV. But now the hardware has evolved to the point that a feature created by the Machinima community could be shown on a Saturday morning TV show. [20]

Already, Machinima can replace or enhance the idea of storyboarding. With Machinima, storyboards can be rendered in real time, giving the director a clear idea of shots, images and camera movements. Katherine Anna Kang, Chief Executive of Fountainhead Entertainment, is an enthusiast:

> To create Machinima, you don't need anything but a game... It is all there, you just capture your footage. But to be able to do complicated, unique stories, you need to be able to program. And that is why we created our machinimation tools. They will be a good way for film-makers to enter the field. [21]

She believes that Machinimation tools will be used to create rough sketches of potential animations, or special effect sequences. After making a low-cost trial run, a director can decide whether or not to go ahead with the shot, which otherwise might take hours to render or involve waiting for the results of numerous tests with film.

Developments in games software will push the boundaries of Machinima out further. *Strange Company*, the makers of *Matrix 4X1* already combines traditional Machinima techniques with industry-standard 3D applications like *3D Studio Max*, *Lightwave* and *Adobe After Effects*. This use of traditional animation and modelling technology, together with games-based production techniques can generate top-quality films and stories. Already, however, *Strange Company* has developed an entirely new Machinima production suite, called *Antics,* that allows professional film-makers more control and precision than 3D applications provide.

---

[20] Bieve, Celeste. **Op.cit.** pp 28-31.
[21] **lbid.** pp 28-31.

At the moment, the *Quake III* engine has constraints such as limiting *Quake III* characters to standard motions such as walking, running, jumping, and crouching. The animation of characters in *Quake III* is ‘frame based’ rather than ‘skeletal’ based, meaning that the character is pre-programmed to do certain actions. In skeletal animation, almost all the motions are rendered in real time as the game is played, giving users greater control.

In the new *Doom 3* engine, all the characters will be skeletal based. Katherine Kang says:

> When *Id Software* releases *Doom 3*, we hope to create a version of our tools for Machinima making use of that engine. It will be an incredible step towards flexibility and realism.[22]

Matt "Ill Clinton" Dominianni, from the Ill Clan shares these sentiments:

> The release of *Doom 3* and *Half-Life 2* will make much higher quality Machinima possible, and will likely get the attention of some of the "traditional" computer animation houses. That could be really good, or that could be really bad for us and the rest of the current crop of Machinima movie-makers. We'll find out soon enough.[23]

With the anticipated release of *Doom 3*[24], and *Quake 4*, using the new *ID Software* ‘engine’, Machinima will take a step to a whole new level.

Machinima has already been incorporated into some productions such as *Final Fantasy: A Spirit Within*, where a scene was rendered in a low quality real time. This cannot be counted as a does not fully fledged Machinima as it was not acted in real time, but it does give a full running version in a low output. In another example, George Lucas' Industrial Light and Magic used the *Unreal* game engine to storyboard *Star Wars* movies.

---

[22] Bieve, Celeste. **Op.cit.** pp 28-31.
[23] “Interview ILL Clan”, Machinima.com, 2004.
[24] Game to be released on 14/07/2004, Official date from Id Software’s website

Conclusion

Animation is all about excitement. Why would anyone want to watch a cartoon animation of an event that could be just as easily filmed and better represented, using an off-the-shelf digital camera? The reason for the excitement is that we humans enjoy the novelty of the unreal. We are amazed at our own limited ability to mimic nature. And we delight in transforming things to our own fashion.

The thaumatrope displayed a simple image of a bird in a cage and the flip-book shows simple movement. Yet they were wonders of their time. As technology developed, animators went on to create new wonders. Machinima is just the latest wonder bestowed by technology. It is still unusual and not very well known or understood outside the animation industry, but it has got its foot in the door and is here to stay.

Machinima is not the whole future of animation, but it is likely to emerge as an important sub-set. It is unlikely to replace traditional cell animation or computer-generated animation anytime soon, but it will find its own space as a new development, using new experimental techniques and new technology. It will grow as it delivers on the promise of its advantages:

- Savings of time and money: Machinima movies can be developed faster and made more quickly and easily than traditional or computer-generated animations.
- Flexibility: Machinima movies can be shot from an infinite number of cameras and angles, opening up whole new palettes of effects.
- Collaboration: Machinima movies are made in a virtual electronic space and can be made across borders and cultures, allowing cooperation of an unprecedented nature.
- Popularisation and democratisation: Machinima's ease of use and the availability of open source software have empowered a completely new breed of film-makers who will expand the breadth and depth of the animation industry.

These benefits should guarantee Machinima an exciting future.

Glossary

3-D. Three Dimensional.
Afterimage. The visual image the brain retains for a fraction of a second after one image is removed.
Bullet Time. Slow motion panoramic shot, used in The Matrix, using individual still image in a long sequence.
Computer Assisted Animation. Computer-assisted animation usually refers to 2 dimensional (2D) and 2½ dimensional (2½D) systems that computerize the traditional hand-drawn animation process.
Cells. Translucent celluloid paper..
CGI. *See,* Computer Generated Images.
Computer Generated Image. Animated graphics produced by computer.
Edward Muybridge. British-born American motion-picture pioneer particularly noted for his series of photographs of horses in motion, taken by a set of still cameras.
Engine (Game). The code or instructions underlying a game.
Field of Vision. The width of the field that the camera.
First Person Shooter. Computer games where the player sees the virtual world through his own eyes, i.e., from a first person point of view.
Flipbook. A series of images that give the illusion of continuous movement when the edges of the pages are flipped quickly.
FPS. See, First Person shooter, Frames Per Second.
Frames Per second. Frame Rate of a motion picture.
Halo. Game/Game Engine created by Microsoft.
John Bray. Patented the use of Cells in animation.
John Lasseter. Executive Vice President, Pixar.
Machinima. (Ma-sheen-EH-ma)- “Machine-animation-cinema”. Animation created in the 3 dimension virtual environment of a computer game.
Matrix, The. Warner Brothers Film, directed and written by the Wachowski brothers.
Mods. Modifications made to a computer game.
Multi-plane camera stand. Tool allowing different layers of cells to be positioned at different distances from the lens and to be moved at different rates, thus, creating an illusion of depth and zooming.
Quake III. Game/Game Engine created by id software.
Persistence of vision. *See* : Afterimage.
PIXAR. 3D Animation Company responsible for movies such as *Toy Story*.
Renderman. RenderMan11® is a rendering software system which puts together complete digital information for a 3-D animated scene.
Scanimate. .Early 3D animation using *Sketchpad*.
SIGGRAPH. A convention focusing on research, art, animation, games, interactivity, and web graphics.
Sketchpad. Sketchpad pioneered the concepts of graphical computing, including memory structures to store objects, rubber-banding of lines, the

ability to zoom in and out on the display, and the ability to make perfect lines, corners, and joints.
Stop Motion Animation. Process of Animation in recording individually positioned models, frame by frame.
Storyboard. A panel or series of panels of rough sketches outlining the scene sequence and major changes of action or plot in a production.
Thaumatrope. An optical instrument for showing the persistence of vision.
Walt Disney. Founder of *The Walt Disney Company*, creator of the first animated film, with sound, and full length animated feature.
Zoetrope. A hollow drum with a series of pictures around its inner surface, and slits cut down through the drum to look into.
Zoopraxiscope. Instrument similar to, the Zoetrope, but the pictures were projected.

Bibliography

1. Books:

Bryman, Alan. Disney and his Worlds. London, New York, Routledge, 1995.

Crafton, Donald. Before Mickey: The Animated Film, 1898-1928. Chicago, University of Chicago Press, 1993.

Culhanne, Shamus. Animation: From Script to Screen. London, Columbus Books, 1988

Foley, van Dam, Feiner, and Hughes. Computer Graphics Principles and Practice, second edition. Addison Wesley, 1990.

Kerlow and Rosebush. Computer Graphics. NY, Van Nostrnd Reinhold, 1986.

Manvell, Roger. Art & Animation: The Story of Halas & Batchelor Animation Studio 1940/1980. New York, Hasting's House, 1980

Parent, Rick. Computer Animation: Algorithms and Techniques. Morgan-Kaufmann, 2001.

Sherman, Eric. Frame By Frame: A Handbook for Creative Film Making. Los Angeles, Acrobat Books, 1987.

Thomas, Frank and Johnston, Ollie. Disney Animation: The Illusion of Life. NY, Abbeville Press, 1981.

Watt, Alan. 3D Computer Graphics, second edition. Addison Wesley, 1993.

Watt, Alan and Watt, Mark. Advanced Animation and Rendering Techniques Theory and Practice. Addison Wesley, 1992.

2. Articles:

Bieve, Celeste. “The animation game, Technology.” The New Scientist, Vol. 180, No. 2418, October 2003, pp 28-31.

Milne, Mike. “Real Animators Don’t Rotoscope, Or Do They?” Entertaining the future. ACM SIGGRAPH, Vol.32 No.2 May, 1998.

Rouse, Richard. “Embrace Your Limitations — Cut-Scenes in Computer Games”, ACM SIGGRAPH, Vol.32 No.4, November 1998.

Sturman, David. “The State of Computer Animation,” Retrospective.” ACM SIGGRAPH, Vol.32 No.1, February 1998.

3. Electroninc Material:

Articles:

ACM SIGGRAPH, Computer Animation, Traditional Film Camera Techniques, 2000. Visited 18.12.2003 http://www.siggraph.org/education/materials/HyperGraph/animation/cameras/traditional_film_camera_techniqu.htm

ACM SIGGRAPH, Computer Graphics Hardware Overview. Display Devices, 1999. Visited 14.12.2003 http://www.siggraph.org/education/materials/HyperGraph/hardware/hardware.htm

Branwyn, Gareth. Desktop Directors Chair, ScreenNagger Central. Visited 16.01.2004 http://www.screenagercentral.com/futurelooks/happen/desktop_director/

Deakin University, Development of Computer Graphics, Evolutionary Stages of Technology, 2000. Visited 10.02.2004 http://www.deakin.edu.au/~agoodman/scc308/topic10.html

MVWIRE, Zero 7's "In the Waiting Line", MVWIRE.com. 2003. Visited 02.02.2004 http://www.mvwire.com/dynamic/article_view.asp?AID=10325

PIXAR, About Us, Corporate Overview, PIXAR. Visited 05.12.2003 http://www.pixar.com/companyinfo/aboutus/index.html

Strange Company, The Matrix 4x1. Cybernetic Productions, 2000. Visited 30.01.2004 http://www.strangecompany.org/matrix/index.php?id=1

Steve Upstill, The Renderman Companion, Addison Wesley, 1990, Chapter 3. Visited 18.12.2003 http://www.siggraph.org/education/materials/renderman/gso_tutorial/structure_of_a_renderman_program.htm

Tom Loftus, "Lights, camera, and… Machinima!" A New York City film festival is all about fun and games. MSNBC.com. 2004. Visited 24.02.2004 http://msnbc.msn.com/id/3341680/

Walt Disney Studio's, History of Walt Disney Studios, Disney. Visited 05.12.2003 http://disney.go.com/StudioOperations/Welcome/history.html

Encyclopaedia Article:

"Animation," Microsoft® Encarta® Online Encyclopedia 2004
http://encarta.msn.com © 1997-2004 Microsoft Corporation.

"Disney, Walt(er Elias)," Microsoft® Encarta® Online Encyclopedia 2004
http://encarta.msn.com © 1997-2004 Microsoft Corporation.

"Motion Pictures, History of," Microsoft® Encarta® Online Encyclopedia 2004
http://encarta.msn.com © 1997-2004 Microsoft Corporation.

"Motion Picture," Microsoft® Encarta® Online Encyclopedia 2004
http://encarta.msn.com © 1997-2004 Microsoft Corporation.

Interviews:

"Ask strange Company: Part 1", Machinima.com, 2001.
http://www.machinima.com/displayarticle2.php?article=19

"Interview ILL Clan", Machinima.com. 2004.
http://www.machinima.com/displayarticle2.php?article=410

Additional:

www.e3expo.com Visited 01.03.2004

www.idsoftware.com. Visited 29.02.2004

www.redvsblue.com Visited 05.01.2004

http://www.siggraph.org Visited 16.01.2004

http://whatisthematrix.warnerbros.com/ Visited 05.02.2004

Filmography

A Bugs Life. Disney/PIXAR
USA 1998 96mins Technicolor
Writers: John Lasseter, Andrew Stanton
Director: John Lasseter, Andrew Stanton
Music: Randy Newman

Adventures of André and Wally B, The. PIXAR
USA 1984 2mins Color
Writers: John Lasseter
Director: John Lasseter

Bambi. Disney
USA 1942 70mins Technicolor
Writers: Larry Morey
Director: David Hand
Music: Edward H

Chicken Run. Aardman Animation/Pathe/DreamWorks SKG
UK 2000 84mins Technicolor
Writers: Peter Lord, Nick Park
Director: Peter Lord, Nick Park
Music: Harry Gregson-Williams

Fantasia. Disney
USA 1940 120mins Technicolor
Writers: Joe Grant Dick Huemer
Director: James Algar and Samuel Armstrong
Music: Various

Final Fantasy The Spirit Within. Square Soft
USA/JAPAN 2001 106mins DeLuxe
Writers: Hironobu Sakaguchi, Al Reinert
Director: Hironobu Sakaguchi, Moto Sakakibara
Music: Elliot Goldenthal

Finding Nemo. Disney/PIXAR
USA 2003 100mins Technicolor
Writers: Andrew Stanton
Director: Andrew Stanton, Lee Unkrich
Music: Randy Newman

Flowers and Trees. Disney
USA 1932 8mins 3-Strip Technicolor
Director: Burt Gillett

King Kong
USA 1933 120mins Black and White
Writers: Merian C. Cooper, Edgar Wallace
Director: Merian C. Cooper, Ernest B. Schoedsack
Music: Max Steiner

Luxo Jr.. PIXAR
USA 1984 2mins Color
Writers: John Lasseter
Director: John Lasseter

Matrix, The. Warner Brothers
USA 1999 136mins Technicolor
Writers: Andy Wachowski, Larry Wachowski
Director: Andy Wachowski, Larry Wachowski
Music: Jack Dangers

Monsters Incorporated. Disney/PIXAR
USA 2001 92mins Technicolor
Writers: Jill Culton, Robert L. Baird
Director: John Lasseter, David Silverman
Music: Randy Newman

Snow White and the Seven Dwarfs. Disney
USA 1937 83mins Technicolor
Writers: Ted Sears, Richard Creedon
Director: Uncredited
Music: Frank Churchill

Star Wars. Lucas Arts
USA 1977 121mins Technicolor
Writers: George Lucas
Director: George Lucas
Music: John Williams

Steamboat Willie. Disney
USA 1928 8mins Black and White
Writers: Walt Disney, Ub Iwerks
Director: Walt Disney, Ub Iwerks
Music: Bert Lewis (uncredited)

Toy Story Disney/PIXAR
USA 1995 81mins Technicolor
Writers: John Lasseter, Peter Docter
Director: John Lasseter
Music: Randy Newman

Toy Story 2 Disney/PIXAR
USA 1995 92mins Technicolor
Writers: John Lasseter, Peter Docter
Director: John Lasseter, Ash Brannon
Music: Randy Newman

Other Films Mentioned

Oswald the Rabbit	1926	*Dir*: Walt Disney
Pinocchio	1940	*Dir*: Hamilton Luske and Ben Sharpsteen
The Abyss	1989	*Dir*: James Cameron
Tron	1982	*Dir*: Steven Lisberger
Terminator 2	1991	*Dir*: James Cameron
Jurassic Park	1993	*Dir*: Steven Spielberg
Scanimate	1969	*Dir*: Lee Harrison III
Anachronox	2002	*Dir*: Jake Hughes
Red versus Blue - Blood Gulch Chronicles	2003	*Dir*: *Red Versus Blue ensemble*
Alleyway	2002	*Dir*: *Strange Company ensemble*
Control Room	2002	*Dir*: *Strange Company ensemble*
Subway	2002	*Dir*: *Strange Company ensemble*
Waking Life	2001	*Dir*: Tommy Pallotta
Figures of Speech	2000	*Dir*: Tommy Pallotta
Destiny	2001	*Dir*: Tommy Pallotta