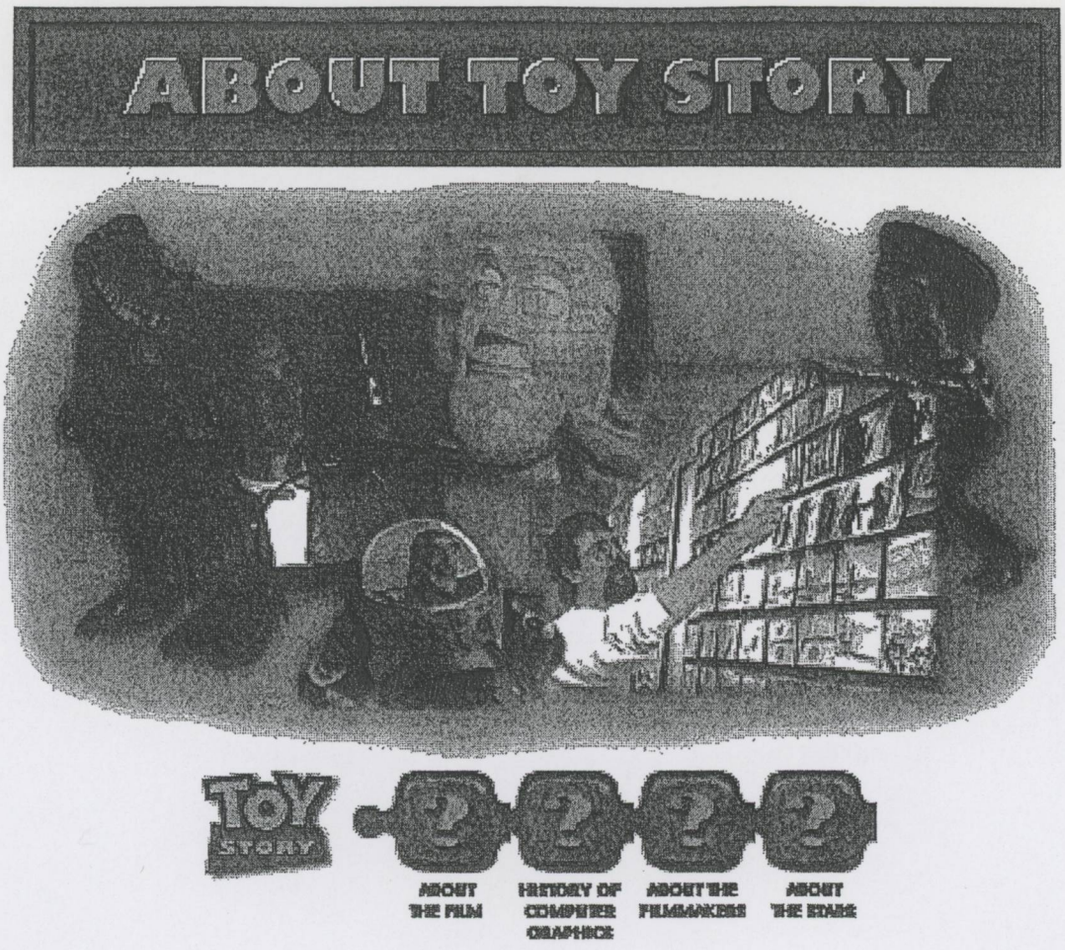
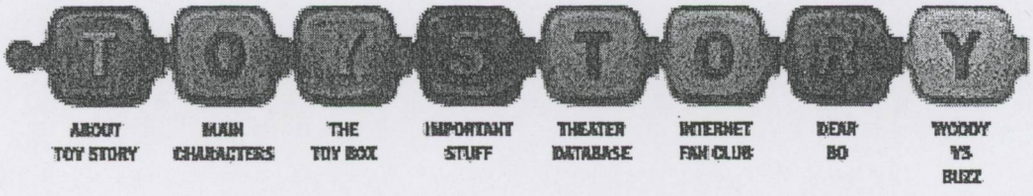


ABOUT TOY STORY

What do you want to know about "Toy Story"? Credits? How many hours it took the computers to render the final animations? (800,000). How many animation variables control Woody's mouth? (58). Who lends their voice to the many unique characters? All you have to do is browse through this section and the rest of the "Toy Story" web site to find out.

Every week during "Toy Story's" theatrical release, we'll update the site with new information and entertaining pages relating to the film. Have fun. And enjoy "Toy Story."

For problems downloading/playing files in this section, get help by clicking below:
Windows Tech Notes Macintosh Tech Notes



Comments? Email the Webmaster at andys-room@www.toystory.com.
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ABOUT THE FILM

ABOUT THE FILM

Okay, all you graphics-designing, software-consuming, code-writing, chat-rooming, e-mailing, texture-mapping, game-playing, toy-collecting, edge-cutting, animation-loving browsers of the wel . . . we've got a film for you.



A co-production of Walt Disney Pictures and Pixar, "Toy Story" is the first completely computer-animated feature film in the history of motion pictures. Directed by Academy Award-winning filmmaker John Lasseter and featuring the voices of Tom Hanks and Tim Allen, "Toy Story" is a film unlike anything you've ever seen before, with remarkably realistic animation startling depth, dimension and style.

"Toy Story" begins in a young boy's bedroom, where the toys come to life when people aren't around (Duh! Whose toys don't?). The boy, whose name is Andy, has a favorite toy, a beat-up olc cowboy doll named Woody. Pull Woody's string, and he says things like, "Somebody poisoned th water hole!" and "Reach for the sky!" Woody maintains law and order in Andy's room. He is looked up to and respected by all the other toys . . . until Andy's eighth birthday . . . when a new toy turns Woody's world upside-down.

His name is Buzz Lightyear. He's a Space Ranger, a member of the elite Universe Protection Unit, sworn to defend the galaxy against the Evil Emperor Zurg. He's equipped with a laser, retractable j wings, and a microchip processor which gives him a vocabulary superior to that of your average high school science teacher. Buzz doesn't actually know he's a toy. Needless to say, he's headed f a serious existential crisis. And a showdown with sheriff Woody looms.

Tom Hanks, a hand-crafted piece of Americana himself, is the voice of Woody. Tim Allen, whose way with power tools has made him known throughout the Gamma Quadrant of Sector Five, bring his star power to the voice of Buzz Lightyear. Don Rickles is Mr. Potato Head. Annie Potts is Bo Peep. John Ratzenberger (Cliff from "Cheers") is Hamm, the piggy bank. Jim Varney (of "Ernest" fame) is Slinky Dog. Wally Shawn is Rex, the green plastic tyrannosaurus.

Be sure to check back often -- we'll be updating the site with new information each week!

Animation and Layout

- Smallest animation staff for a Disney animation feature
- No motion-capture is used in the entire film - everything is animated by hand
- Most complicated shot: Army men attacking Woody. To get a feel for how many Army m would walk on solid bases, animators nailed a pair of shoes to piece of plywood and hopped around
- Total number of animated cameras: 620 That means over 1/3 of all shots in the film involv a moving camera
- Total number of shots omitted from the film: 250
- A typical tree has around 10,000 leaves. Somewhere between 5,000-12,000. Clumps are usually anywhere from 50 to 200 leaves and most trees have a fair number of clumps (30-60). The trees average about 2 to 5 megabytes of rip code.
- There are about 100-200 trees in the block - that makes 1,200,000 leaves on Andy's block alone. That's a lot of leaves!

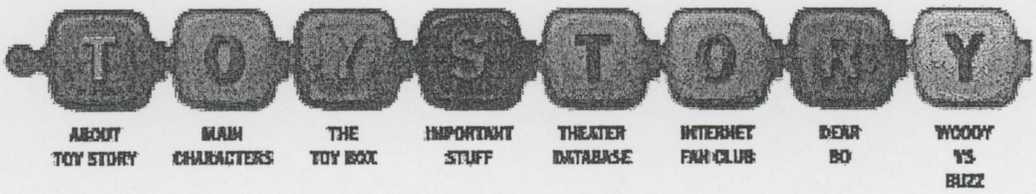
Paint Department

- Over 2000 texture maps painted for Toy Story
- Approximately 125 flats -- used as static backgrounds to provide rich color and depth.
- Sid's room general filth: 102 paintings, not including general dirt, desk, etc.

  7 blotches
  2 crayon marks
  4 mosses
  5 rusts
  3 brushmarks
  16 splats
  4 dirt
  1 drip
  2 holes
  2 scrapes
  4 spills
  8 cup rings
  3 smudges
  2 drips
  2 sprays
  14 drips
  3 wood grain chips
  1 rug dirt
  15 scratches
  6 watermarks

- Number of layers on human skin: 10

  blood
  epidermal
  oil 1
  oil 2
  oil 3 (lips)
  hair (near scalp)
  roughness
  wrinkle



Comments? Email the Webmaster at andys-room@www.toystory.com.

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ADVANCES OF THE 1980s

Excepted from the book, "Becoming a Computer Animator"
by Michael Morrison

Introduction

Pixar | Disney | Toy Story | Beauty and the Beast

Ed Catmull | Ralph Guggenheim | John Lasseter | William Reeves | Renderman

Advances of the 1960s | Advances of the 1970s |Advances of the 1990s

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During the early 1980's SIGGRAPH was starting to really take off. Catmull explains, "SIGGRAP was a very good organization. It was fortuitous to have the right people doing the right things at the right time. It became one of the very best organizations where there is a lot of sharing and a lot of openness. Over the years it generated a tremendous amount of excitement and it was a way of getti a whole group of people to work together and share information, and it is still that way today."

At the 1980 SIGGRAPH conference a stunning film entitled "Vol Libre" was shown. It was a computer generated high-speed flight through rugged fractal mountains. A programmer by the nam of Loren Carpenter from The Boeing Company in Seattle, Washington had studied the research of Mandelbrot and then modified it to simulate realistic fractal mountains.

Carpenter had been working in the Boeing Computer Services department since 1966 and was an undergraduate at the University of Washington. Starting around 1972 he started using the University's engineering library to follow the technical papers being published about computer graphics. He eventually worked his way into a group at Boeing that was working on a computer aided drawing system. This finally got him access to computer graphics equipment. Working there with other employees, he developed various rendering algorithms and published papers on them.

In the late 70s Carpenter was creating 3D rendered models of aircraft designs and he wanted some scenery to go with his airplanes. So he read Mandelbrot's book and was immediately disappointed when he found that the formulas were not practical for what he had in mind. Around this time "Sta Wars" had been released and being a big fan of the imagination Carpenter dreamed of creating som type of alien landscape. This drove him to actually do it; by 1979 he had an idea about how to creat fractal terrain in animation.

While on a business trip to Ohio State in 1979, Carpenter ran into a person who knew quite a few people in the computer graphics field including individuals like Ed Catmull. He explained how Catmull had just been hired by George Lucas to set up a lab at Lucasfilm. Carpenter was immediately interested but didn't want to send in his resume yet, because he was still working on h fractal mountain movie. "At the time they were getting enough resumes to kill a horse" explains Carpenter.

Carpenter continues, "I wanted to demonstrate that these (fractal) pictures would not only look goo but would animate well too. After solving the technical difficulties, I made the movie, wrote a pape to describe it and made a bunch of still images. I happened to be on the A/V crew of SIGGRAPH 1980, so one of my pictures ended up on an A/V T-shirt. I had this campaign to become as visible : possible because I wanted to work at Lucasfilm and when I showed my film, the people from Lucasfilm were there in the audience. Afterward they spoke to me and said, 'You're in, we want you.'" Later, in 1981 Carpenter wrote the first renderer for Lucasfilm, called REYES (Renders Everything You Ever Saw). REYES would eventually turn into the Renderman rendering engine ar today, Carpenter is still with Pixar.

Turner Whitted published a paper in 1980 about a new rendering method for simulating highly reflective surfaces. Known today as Ray Tracing, it makes the computer trace every ray of light, starting from the viewer's perspective back into the 3D scene to the objects. If an object happens to be reflective, the computer follows that ray of light as it bounces off the object until it hits somethin else. This process continues until the ray of light hits an opaque non-reflective surface or it goes shooting off away from the scene. As you can imagine, ray tracing is extremely computational intensive. So much so that some 3D animation programmers (such as the Yost Group who created 3D Studio) refuse to put ray tracing into their software. On the other hand, the realism that can be achieved with ray tracing is spectacular.

Around 1980 two individuals, Steven Lisberger, a traditional animator, and Donald Kushner, a lawyer-turned-movie distributor decided to do a film about a fantasy world inside a video game. After putting together a presentation, Lisberger and Kushner sought backing from the major film companies around Los Angeles. To their surprise, it was Tom Wilhite, a new production chief at Disney, that took them up on the idea. After many other presentations to Disney executives, they were given the 'OK' from Disney to proceed.

The movie, called "Tron," was to be a fantasy about a man's journey inside of a computer. It called for nearly 30 minutes of film quality computer graphics, and was a daunting task for computer graphics studios at the time. The solution lay in splitting up various sequences and farming them ou to different computer graphics studios. The two major studios were Triple I and MAGI (Mathematical Applications Group Inc.). Also involved were NYIT, Digital Effects of New York and Robert Abel & Associates.

The computer generated imagery for "Tron" was very good but unfortunately the movie as a whole was very bad. Disney had sunk about $20 million into the picture and it bombed at the box office. This, if anything, had a negative influence on Hollywood toward computer graphics. Triple I had created computer graphics for other movies such as Looker in 1980, but after "Tron," they sold off their computer graphics operation. Demos and Whitney left to form a new computer graphics company called Digital Productions in 1981.

Digital Productions had just got started then they landed their first major film contract. It was to create the special effects for a Sci-Fi movie called "The Last Starfighter." In Starfighter, however, everyone made sure that the story was somewhat good before generating any computer graphics. Digital Productions invested in a Cray X-MP supercomputer to help process the computer graphics frames. The effects themselves were very impressive and photorealistic but the movie cost $14 million to make and only grossed about $21 million - enough to classify as a "B" grade movie by Hollywood standards - it still didn't make Hollywood sit up and take notice of computer graphics.

Carl Rosendahl launched a computer graphics studio in Sunnyvale, California in 1980 called Pacifi Data Images (PDI). Rosendahl had just graduated from Stanford University with a degree in electrical engineering and for him, computer graphics was the perfect solution for his career interes television production and computers. A year later Richard Chuang, one of the partners, wrote some anti-aliasing rendering code, and the resulting images allowed PDI's client base to increase. While other computer graphics studios were focusing on film, PDI focused solely on television network ID's, such as the openings for movie-of-the-week programs. This allowed them to carve a niche fo themselves. Chris Woods set up a computer graphics department in 1981 at R/Greenberg Associate in New York. In August of 1981 IBM introduced their first personal computer, the IBM PC. The IBM PC, while not the most technologically advanced personal computer, seemed to break PCs int the business community in a serious way. It used the Intel 16-bit 8088 microprocessor and offered ten times the memory of other personal computer systems. From then on, personal computers became serious tools that business needed. With this new attitude toward PCs came tremendous sales as PCs spread across the country into practically every business.

Another major milestone in the 1980's for computer graphics was the founding of Silicon Graphics Inc. (SGI) by Jim Clark in 1982. SGI focused its resources on creating the highest performance graphics computers available. These systems offered built-in 3D graphics capabilities, high speed RISC (Reduced Instruction Set Chip) processors and symmetrical (multiple processor) architecture The following year in 1983, SGI rolled out its first system, the IRIS 1000 graphics terminal.

In 1982, Lucasfilm signed up with Atari for a first-of-its-kind venture between a film studio and video game company. They planned to create a home video game based on the hit movie "Raiders c the Lost Ark." They also made plans to develop arcade games and computer software together. Some of Lucasfilm's games included PHM Pegasus, Koronis Rift, Labyrinth, Ballblazer, Rescue c Fractalus and Strike Fleet. They also developed a networked game called Habitat that is still very popular in Japan. Today the LucasArts division of Lucasfilm creates the video games and is a stron user of 3D computer graphics.

In 1982, John Walker and Dan Drake along with eleven other programmers established Autodesk Inc. They released AutoCAD version 1 for S-100 and Z-80 based computers at COMDEX (Computer Dealers Exposition) that year. Autodesk shipped AutoCAD for the IBM PC and Victor 9000 personal computers the following year. Starting from 1983, their yearly sales would rise fron 15,000 dollars to 353.2 million dollars in 1993 as they helped move computer graphics to the worl of personal computers.

At Lucasfilm, special effects for film were handled by The Industrial Light and Magic (ILM) division, yet early on they didn't want much to do with computer graphics. Catmull explains, "The considered what we were doing as too low of a resolution for film. They felt it didn't have the quality, and they weren't really believers in it. There wasn't an antagonistic relationship between u we got along well, it was just that they didn't see computer graphics as being up to their standards. However, as we developed the technology we did do a couple pieces such as the Death Star projection for 'Return of the Jedi.' It was only a single special effect yet it came out looking great." For "Return of Jedi" in 1983, Lucasfilm created a wireframe "hologram" of the Death Star under construction protected by a force field for one scene.

The computer graphics division of Lucasfilm was next offered a special effects shot for the movie "Star Trek II: The Wrath of Kahn." There was an effect that could have been done either traditional or with CGI. The original screenplay called for the actors to go into a room containing a coffin shaped case in which could be seen a lifeless rock. The "Genesis" machine would then shoot this rock and make it look green and lifelike. ILM, however, didn't think of that as very impressive, so they went to the computer graphics division and asked if they could generate the effect of the rock turning life-like. Then Alvy Ray Smith came back and said, "Instead of having this rock in front of this glass box why don't we do what's meant to be a computer simulation and a program showing

how it works for the whole planet." Thus Smith came up with the original idea and ILM decided to go for it. And so they generated a one minute long sequence. It was largely successful because it was meant to be a computer generated image in the movie, so it didn't need to have the final touche of realism added to it. The effect was rendered on Carpenter's new rendering engine, REYES. It turned out to be a very, very successful piece. As Smith would later say, "I call it 'the effect that never dies' It appeared in three successive Star Trek movies, Reebok and other commercials, the Sci-Fi channel, you see it everywhere." Following the "Genesis" effect, Lucasfilm used computer graphics for the movie "Young Sherlock Holmes" in 1985. In this movie, a stained glass window comes to life to terrorize a priest.

Tom Brigham, a programmer and animator at NYIT, astounded the audience at the 1982 SIGGRAPH conference. Tom Brigham had created a video sequence showing a woman distort an transform herself into the shape of a lynx. Thus was born a new technique called "Morphing". It was destined to become a required tool for anyone producing computer graphics or special effects i the film or television industry. However, despite its impressive response by viewers at the conference, no one seemed to pay the technique much attention until a number of years later in 198 when LucasFilm used the technique for the movie "Willow" in which a sorceress was transformed through a series of animals into her final shape as a human.

Scott Fischer, Brenda Laurel, Jaron Lanier along with Thomas Zimmerman worked at the Atari Research Center (ARC) during the early eighties. Jaron Lanier, working for Atari as a programmer in 1983, developed the DataGlove. A glove for your hand wired with switches to detect and transm to the computer any movements you make. The computer interprets the data and allows you to manipulate objects in 3D space within a computer simulation. He left later that year and teamed up with Jean-Jacques Grimaud; together they founded a company 2 years later in 1985 called VPL Research, which would develop and market some of the first commercial virtual reality products. Zimmerman, an MIT graduate who had developed the "Air Guitar" software and a DataGlove that allowed you to play a virtual guitar, also joined VPL Research. Zimmerman left in 1989 while Lani stayed with VPL Research until November of 1992.

AT&T formed the Electronic Photography and Imaging Center (EPIC) in 1984 to create PC-based videographic products. In the following year they released the TARGA video adapter for personal computers. This allowed PC users for the first time to display and work with 32-bit color images o the screen. EPIC also published the TGA Targa file format for storing these true color images.

Early animation companies such as Triple-I, Digital Productions, Lucasfilm, etc. had to write their own software for creating computer graphics, however this began to change in 1984. In Santa Barbara, California a new company was formed called Wavefront. Wavefront produced the very first commercially available 3D animation system to run on off-the-shelf hardware. Prior to Wavefront, all computer graphics studios had to write their own programs for generating 3D animation. Wavefront started a revolution that would shape the future of all computer graphics studios. Also in that same year, Thomson Digital Image (TDI) was founded by three engineers working for Thomson CSF, a large defense contractor. TDI released its 3D animation software in 1986.

Up until this point, all of the image synthesis methods in use were based on incidental light, where light source was shining directly on a surface. However, most of the light we see in the real world diffused or light reflected from surfaces. In your home, you may have halogen lamps that shine incidental light on the ceiling, but then the ceiling reflects diffuse light to the rest of the room. If yo were going to create a 3D computer version of the room, you might place a light source in the lamp shining up on the ceiling. However, the rest of the room would appear dark, because the software based on direct light, incidental light and it would not reflect off the ceiling to the rest of the room. To solve this problem, a new rendering method was needed and in 1984 Cindy Goral, Don Greenberg and others at Cornell University published a paper called, "Modeling the Interaction of Light Between Diffuse Surfaces." The paper described a new method called Radiosity that uses the

same formulas that simulate the way heat is dispersed throughout a room to determine how light reflects between surfaces. By determining the exchange of radiant energy between 3D surfaces ver realistic results are possible.

In January of 1984, Apple Computer released the first Macintosh computer. It was the first persona computer to use a graphical interface. The Mac was based on the Motorola microprocessor and use a single floppy drive, 128K of memory, a 9" high resolution screen and a mouse. It would become the largest non IBM-compatible personal computer series ever introduced.

Around 1985, multimedia started to make its big entrance. The International Standards Organizatio (ISO) created the first standard for Compact Discs with Read Only Memory (CD-ROM). This new standard was called High Sierra, after the area near Lake Tahoe, where ISO created the standard. This standard later changed into the ISO 9660 standard. Today multimedia is a major marketplace f personal computer 3D animation. In that same year, Commodore launched the new Amiga personal computer line. The Amiga offers many advanced features, including a hardware level compatibility with the IBM personal computer line. The Amiga uses Motorola's 68000 microprocessor and has i own proprietary operating system. The base unit's retail price is $1,295.

Daniel Langlois in Montreal, Canada founded a company called Softimage in 1986. Then in early 1987 he hired some engineers to help create his vision for a commercial 3D computer graphics program. The Softimage software was released at the 1988 SIGGRAPH show and it became the animation standard in Europe with over 1,000 installations world-wide by 1993.

During this time, Jim Henson of Muppets fame approached Brad DeGraf at Digital Productions wit the idea of creating a digital puppet. Henson had brought with him a Waldo unit that he had previously used to control one of his puppets remotely. The device had gotten its name from NASA engineers years earlier. They in turn had taken the name from a 1940's Sci-Fi book written by Robert A. Heinlein about a disabled scientist who built a robot to amplify his limited abilities. The scientist's name was Waldo. Thus when NASA (and later Henson) built their own version of the unit, they dubbed it Waldo.

The programmers at Digital Productions managed to hook up the Waldo and create animation with but that animation was never used for a commercial project. Still, the idea of Motion Capture was born. Today motion capture continues to be a major player in creating computer graphics. As for Digital Productions, at the time things were going great. They had purchased a Cray X-MP supercomputer because it was the fastest computer that money could buy. They were interfacing fil recording and scanning equipment and they had about 75 to 100 employees. They had just finished their fist big movie project, "The Last Starfighter" and they did some special effects scenes for the movie 2010 (the swirling surface of Jupiter). They also worked on "Labyrinth" in 1986. Things were going very well for Digital Productions, perhaps things went too well.

In 1986 the two largest computer graphics houses in the United States were bought out by Omnibu Computer Graphics Inc. in hostile takeovers, Digital Productions (in June) and Robert Abel & Associates Inc. (in October). The reason this is significant, is that both companies had invested heavily in high-end supercomputers like the Cray X-MP (which cost about $13 million each). This had put the focus on buying the fastest number cruncher money could buy and then creating your own custom software.

As soon as Omnibus took control of Digital Productions the two co-founders of Digital, John Whitney and Gary Demos, sued the majority owner of Omnibus, Santa Clara-based Ramtek, for a portion of the sale proceeds. Omnibus subsequently locked both of them out of their offices at Digital Productions in July of 1986. In September Omnibus obtained a temporary restraining order against Whitney and Demos alleging that Whitney and Demos founded a competing firm, Whitney Demos Productions, and had hired at least three employees away from Omnibus and were using

software and other information that belonged to Omnibus. The restraining order required Whitney and Demos to return certain property temporarily to Omnibus.

In October, Omnibus acquired Robert Abel & Associates Inc. for $8.5 million. However, by Marc of 1987, Omnibus started defaulting on the $30 million it had borrowed from several major Canadian creditors. Most of the debts were the result of acquiring Digital Productions and Robert Abel & Associates the previous year. In May, Omnibus officially closed down and laid off all its employees.

According to Gary Demos, "Abel & Associates was sunk just the same as us. At the time, we were the two largest effects studios, and that crash fragmented the entire industry. It changed the whole character of the development of computer graphics." Talented people from both studios found their way into other animation studios. Jim Rigel went to Boss Films, Art Durenski went to a studio in Japan, some went to PDI, some went to Philips Interactive Media (then known as American Interactive Media), others went to Rhythm & Hues, Metrolight, and Lucasfilm. Whitney and Demc created Demos Productions in 1986. It lasted for two years, then they split up and formed their ow companies in 1988. Whitney formed US Animation Labs, while Demos formed DemoGraphics.

In the personal computer field, computer graphics software was booming. Crystal Graphics introduced TOPAS, one of the first high-quality 3D animation programs for personal computers, ir 1986. Over the years, Crystal Graphics would continue to be a major contender in the PC based 3D animation field. The following year, Electric Image was founded and released a 3D animation package for both SGI machines and Apple Macintosh computers. In Mountain View, California, a new 3D software company was founded under the name Octree Software Inc.. They later changed their name to Caligari Corporation and now offer 3D animation programs for both the Amiga and P platforms.

Also in 1986 computer graphics found a new venue, the courtroom. Known as Forensic Animatio these computer graphics are more geared to technical accuracy than to visual aesthetics. Forensic Technologies Inc. started using computer graphics to help jurors visualize court cases. Still creating Forensic animation today, they have been in the business longer than any other company. Now the use SGI workstations from RS-4000's up through Crimson Reality Engines. For their 3D software they exclusively use Wavefront but have a few interfaces to CAD modeling packages. For 2D animation they use a program called Matador by Parallax.

In that same year, **Disney** made its first use of computer graphics in the film "The Great Mouse Detective." In this first Disney attempt at merging computer graphics and hand draw cel animation, they only used the computer for some of the mechanical devices such as gears and clockworks. A Computer Generated Imagery (CGI) department was formed and went on to work on such films as "Oliver and Company," "The Little Mermaid," "Rescuers Down Under," "Beauty and the Beast" a "Aladdin." With the highly successful results of "Aladdin" and "Beauty and the Beast," Disney has increased the animators in the CGI department from only 2 to over 14.

About this time at Lucasfilm, things were getting a little complicated. The computer graphics divisi wanted to move toward doing a feature length computer animated film. Meanwhile ILM was gettin interested in the potential of computer graphics effects. Catmull explains, "Lucas felt this company was getting a little too wide and he wanted to narrow the focus into what he was doing as a filmmaker. Our goals weren't really quite consistent with his." So the computer graphics division asked if they could spin off as a separate company and Lucas agreed to do that.

It took a year about a year of trying to make that happen. Catmull continues, "One of the last things did was hire two people to come in and start a CGI group for ILM because they still wanted CGI special effects capabilities. So I went out to a number of people but mainly focused on Doug Kay and George Joblove. They turned us down the first time. We talked to them and interviewed them

and they called up and said 'We decided not to come up, because we have our own company.' So I put down the phone and thought 'damn I have to keep on looking.' Then that night I called back again, and said 'Doug, you're crazy! This is the opportunity of a lifetime! Something went wrong i the interview. Come back up here and let's do this thing again.' He said 'OK!' so I brought him up again, we went through it all again, and this time they accepted."

The computer graphics division of ILM split off to become **Pixar** in 1986. Part of the deal was tha Lucasfilm would get continued access to Pixar's rendering technology. It took about a year to separate Pixar from Lucasfilm and in the process, Steve Jobs became a majority stockholder. Ed Catmull became president and Alvy Ray Smith became vice-president. Pixar continued to develop their renderer, putting a lot of resources into it and eventually turning it into Renderman.

Created in 1988, **Renderman** is a standard for describing 3D scenes. Pat Hanrahan of Pixar organized most of the technical details behind Renderman and gave it its name. Since then Hanraha has moved to Princeton University where he is currently Associate Professor of Computer Science

The Renderman standard describes everything the computer needs to know before rendering your 3D scene such as the objects, light sources, cameras, atmospheric effects, and so on. Once a scene converted to a Renderman file, it can be rendered on a variety of systems, from Macs to PCs to Silicon Graphics Workstations. This opened up many possibilities for 3D computer graphics software developers. Now all the developer had to do was give the modeling system the capability producing Renderman compatible scene descriptions. Once it did this, then the developer could bundle a Renderman rendering engine with the package, and not worry about writing their own renderer. When the initial specification was announced, over 19 firms endorsed it including Apollo Autodesk, Sun Microsystems, NeXT, MIPS, Prime, and Walt Disney.

An integral part of Renderman is the use of 'shaders' or small pieces of programming code for describing surfaces, lighting effects and atmospheric effects. Surface shaders are small programs that algorithmically generate textures based on mathematical formulas. These algorithmic textures a sometimes called procedural textures or spatial textures. Not only is the texture generated by the computer, but it is also generated in 3D space. Whereas most texture mapping techniques map the texture to the outside 'skin' of the object, procedural textures run completely through the object in 3D. So if you were using a fractal based procedural texture of wood grain on a cube, and you cut o a section of the cube, you would see the wood grain running through the cube.

The interesting part however was that Kay and Joblove (along with the other CGI specialist at ILM became so efficient and the CGI grew and grew until today the CGI group is ILM. Its not a major department, it is...ILM. This is viewed by some as one of the most stunning developments in computer graphics history. One of the reasons the CGI department became so important is that it succeeded in what it intended to do. They set goals, budgets and they met them. Meanwhile, back a Pixar in December of 1988, Steve Jobs stepped down from his post of Chairman of Pixar, and Ed Catmull took his place. Charles Kolstad, the company's VP of manufacturing and engineering, became the new president.

Paul Sidlo had worked as Creative Director for Cranston/Csuri Productions from 1982 until 1987 when he left to form his own computer graphics studio, ReZ.n8 (pronounced resonate). Since ther ReZ.n8 has continued to be a leader in producing high quality computer graphics attracting such clients as ABC, CBS, Fox, ESPN, NBC along with most of the major film studios.

Jeff Kleiser had been a computer animator at Omnibus were he directed animation for the Disney feature film "Flight of the Navigator." Before Omnibus Kleiser had founded Digital Effects and worked on projects such as "Tron" and "Flash Gordon." As things started to fall apart at Omnibus he did some research into motion capture. Then when Omnibus closed, he joined up with Diana Walczak and formed a new company in 1987, Kleiser-Walczak Construction Company. Their new

firm's specialty was human figure animation. In 1988 they produced a 3-1/2 minute music video with a computer generated character named Dozo. They used motion control to input all of her movements.

Brad DeGraf, also from Omnibus, joined forces with Michael Wahrman to form DeGraf/Wahrman Production company. At the SIGGRAPH conference of 1988, the showed, "Mike the Talking Head" which was an interactive 3D computer animated head. Using special controls, they were abl to make it interact with the conference participants. Later DeGraf would leave Wahrman and go to work for Colossal Pictures in San Francisco.

The Pixar Animation Group made history on March 29, 1989 by winning an Oscar at the Academy Awards for their animated short film, "Tin Toy." The film was created completely with 3D comput graphics using Pixar's Renderman. **John Lasseter** directed the film with **William Reeves** providing technical direction.

At the 1989 SIGGRAPH in Boston, Autodesk unveiled a new PC based animation package called Autodesk Animator. As a full featured 2D animation and painting package, Animator was Autodesk's first step into the multimedia tools realm. The software-only animation playback capabilities achieved very impressive speeds and became a standard for playing animation on PCs.

In 1989 an underwater adventure movie was released called "The Abyss." This movie had a direct impact on the field of CGI for motion pictures. James Cameron, director and screenwriter for Abyss, had a specific idea in mind for a special effect. He wanted a water creature like a fat snake t emerge from a pool of water, extend itself and explore an underwater oil-rig and then to interact wi live characters. He felt it couldn't be done with traditional special effects tools and so he put the effect up for bid and both Pixar and ILM bid on it. ILM won the bid and used Pixar's software to create it. Catmull explains, "We really wanted to do this water creature for the Abyss, but ILM got the bid, and they did a great job on it."

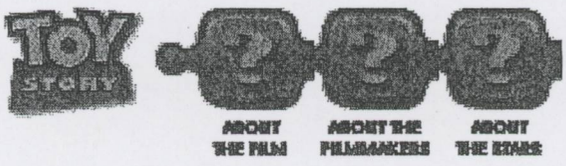
Cameron viewed this effect as a test piece and that if it didn't work out then he could have done without it. But it did work, and it worked so well and had enough of an impact, that it convinced him that CGI could create a major character in his next film which would be "Terminator 2."

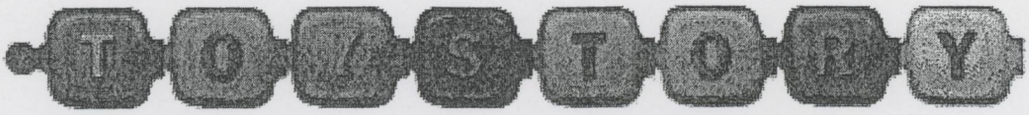
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ADVANCES OF THE 1990s

Excepted from the book, "Becoming a Computer Animator"
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In May of 1990, Microsoft shipped Windows 3.0. It followed a GUI structure similar to the Apple Macintosh, and laid the foundation for a future growth in multimedia. While in 1990 only two of th nation's top ten programs ran under Windows, this rose to nine out of ten just a year later in 1991.

Later that year, in October, Alias Research signed a 2.3 million dollar contract with ILM. The deal called for Alias to supply 3D, state of the art computer graphics systems to ILM for future video production. While ILM in turn would test these new systems and provide feedback.

NewTek, a company founded in 1985, released the Video Toaster in October of 1990. The Video Toaster is a video production card for Amiga personal computers that retails for $1,595. The card comes with 3D animation, and 24-bit paint software and offers video capabilities such as a 24-bit frame buffer, switching, digital video effects, and character generation. The practical video editing uses of the Video Toaster made it very popular, and today it is used on broadcast television shows such as Sea Quest and Babylon 5 for 3D computer graphics.

Also in 1990, AutoDesk shipped their first 3D Computer animation product, 3D Studio. Created fo AutoDesk by Gary Yost (The Yost Group), 3D Studio has risen over the past four years to the lead position in PC based 3D computer animation software.

Disney and Pixar announced in 1991 an agreement to create the first computer animated full length feature film, called **"Toy Story,"** within two to three years. This project came as a fulfillment to those early NYIT'ers who had the dream of producing a feature length film. Pixar's animation group, with the success of their popular Listerine, Lifesavers and Tropicana commercials, had the confidence that they could pull off the project on time and on budget.

"Terminator 2" (T2) was released in 1991 and set a new standard for CGI special effects. The evil T-1000 robot in T2 was alternated between the actor Robert Patrick and a 3D computer animated version of Patrick. Not only were the graphics photorealistic, but the most impressive thing was th the effects were produced on time and under budget.

The same year another major film was released in which CGI played a large role, **"Beauty and th Beast."** After previously having one success after another with computer graphics, Disney pulled out all the stops and used computer graphics throughout the movie. In terms of the beauty, color ar design Disney did things that they could not possibly have done without computers. Many scenes contained 3D animated objects, yet they were flat shaded with bright colors so as to blend in with th hand-drawn characters. The crowning sequence was a ballroom dance in a photorealistic ballroom complete with a 3D crystal chandelier and 158 individual light sources to simulate candles.

The effect of these two movies in 1991 on Hollywood was remarkable. Catmull explains, "So wha happened was in 1991 'Beauty and the Beast' came out, 'Terminator 2' came out and Disney announced that they had entered into a relationship with us to do a feature length film computer animated film for them. Beauty and T2 where phenomenal financial successes and all of a sudden everybody noticed. That was the turning point, for all the ground work that other people had been doing yet hadn't been noticed before. It all turned around in 1991, it was the year when the whole entertainment industry said 'Oh my God!' and it took them by storm. Then they all started forming their groups and their alliances and so forth."

Early in 1991, Steve Jobs gave the axe to all application development at Pixar. Fearing that the selling of application software would discourage other third party software developers from writing software for Job's NeXT computer he halted all application development at Pixar. He gave the employees 30 days to try and spin off a separate company to focus on application software. This of course did not prove to be enough time, so the president of Pixar, Chuck Kolstad, along with abou 30 employees (almost half of Pixar's workers) were laid off. Ed Catmull moved back into the position of president. Pixar lost a lot of talent including Alvy Ray Smith who went on to start a nev company called Altamira (funded by Autodesk) and created a PC version of his IceMan image editing software he created at Pixar. This product is now commercially available on the market und the name, Altamira Composer.

A Technical Award was given to six developers from Walt Disney's Feature Animation Departmen and three developers from Pixar for their work on CAPS. CAPS is a 2D animation system owned l Disney that simplifies and automates much of the complex post-production aspects of creating full length cartoon animations.

In 1993, Wavefront acquired Thomson Digital Image (TDI) which increased Wavefront's market share in the high-end computer graphics market. Wavefront immediately begin integrating products from TDI into their own line of computer graphics software.

Early in 1993, IBM, James Cameron (writer/director/producer), Stan Winston (special effects expert) and Scott Ross (visual effects executive from ILM) joined forces to create a new visual effects and digital production studio called Digital Domain. Located in the Los Angeles area, Digital Domain hopes to give ILM a run for its money. Not to be out done, ILM followed with their own announcement in April to form a joint "media lab" with Silicon Graphics Inc. called JEDI (Joint Environment for Digital Imaging). ILM will get the latest and greatest SGI hardware and SGI will get to use ILM as a testing facility.

PDI opened their Digital Opticals Group in Hollywood to create special effects for motion pictures such as "Terminator 2: Judgment Day," "Batman Returns," and "The Babe." Now, PDI has becom one of the leaders in digital cleanup work such as wire removal, for motion pictures. Often wires ar used for special effects like people flying or jumping through the air. Sometimes scratches occur or

irreplaceable film footage. For "Terminator 2," PDI used image processing to erase the wires that guided Arnold Schwarzenegger and his motorcycle over a perilous jump. PDI uses software to automatically copy pixels from the background and paste them over the pixels that represent the wires.

Another edit for T2 involved a semi truck crashing through a wall and down into a storm ditch. The original shot was made at the wrong angle. So the director wanted the footage flipped left to right, t keep the continuity consistent with surrounding shots. Normally this would not be a problem, yet i this instance a street sign was in the picture, and even the driver could be seen through the windshield of the truck. So these elements prevented the normal flip that any studio could have performed. To solve these problems, PDI first flipped the footage. Then they cut the sign from the unflipped footage and pasted over top of the flipped sign. Then they copied and pasted the driver from the left side of the truck to the right side. The finished sequence looked flawless.

PDI performed many other sleights of hand for the movie "Babe," a documentary about baseball legend Babe Ruth. A number of challenges faced the producers, one of which was that the main actor, John Goodman is right handed, while Babe Ruth was left handed. As you can imagine, this really threw off many scenes where John had to pitch the ball. To resolve this problem, PDI used digital image processing.

To create the effect of a pitch, John Goodman simply mimed it, without using a ball. Then they filmed a left handed pitcher throwing the ball from the same position. Then the baseball from the second shot was composited onto the first shot. However, the actor playing the catcher had to fake along with John Goodman and the result was he didn't catch the ball at the same time it arrived. To solve this problem, they split the scene down the middle and merged the catcher from the second shot into the first shot. This resulted in a flawless left-handed fastball. "Cleanup" special effects lik this have become a mainstay for computer graphics studios in the 80's and 90's.

Nintendo announced an agreement with Silicon Graphics, Inc. (the leader in computer graphics technology) to produce a 64-bit 3D Nintendo platform for home use. Their first product, Ultra64 will be an arcade game to be released in 1994, while a home version will follow in late 1995. The home system's target price will be $250.

In the early 1990's Steven Spielberg was working on a film version of the latest Michael Crichton best seller, "Jurassic Park." Since the movie was basically about dinosaurs chasing (and eating) people, the special effects presented quite a challenge. Originally, Spielberg was going to take the traditional route, hiring Stan Winston to create full scale models/robots of the dinosaurs, and hiring Phil Tippett to create stop-motion animation of the dinosaurs running and movements where their legs would leave the ground.

Tippett is perhaps the foremost expert on stop-motion and inventor of go-motion photography. Go-motion is a method of adding motion blur to stop-motion characters by using computer to move the character slightly while it is being filmed. This new go-motion technique eliminates most of the jerkiness normally associated with stop-motion. As an example, the original King Kong movie simply used stop-motion and was very jerky. ET on the other hand used Tippett's go-motion technique for the flying bicycle scene and the result was very smooth motion. Tippett went to work on Jurassic Park and created a test walk-cycle for a running dinosaur. It came out OK, although no spectacular.

At the same time, however, animators at ILM began experimenting. There was a stampeding herd c Gallimimus dinosaurs in a scene that Spielberg had decided to cut from the movie because it would have been impossible to create an entire herd of go-motion dinosaurs running at the same time. Eric Armstrong, an animator at ILM, however, experimented by creating the skeleton of the dinosaur ar then animating a walk cycle. Then after copying that walk cycle and making 10 other dinosaurs

running in the same scene, it looked so good that everyone at ILM was stunned. They showed it to Spielberg and he couldn't believe it. So Spielberg put the scene back into the movie.

Next they tackled the Tyrannosaurs Rex. Steve Williams created a walk-cycle and output the animation directly to film. The results were fantastic and the full motion dinosaur shots were switched from Tippett's studio to the computer graphics department at ILM.

This was obviously a tremendous blow to the stop-motion animators. Tippett was later quoted in O Production and Post-Production magazine as saying, "We were reticent about the computer-graphic animators' ability to create believable creatures, but we thought it might work for long shots like th stampede sequence." However as it progressed to the point where the CGI dinosaurs looked better than the go-motion dinosaurs, it was a different story, he continues, "When it was demonstrated th on a photographic and kinetic level that this technology could work, I felt like my world had disintegrated. I am a practitioner of a traditional craft and I take it very seriously. It looked like the end."

However, Tippett's skills were very much needed by the computer animators. In order to create realistic movement for the dinosaurs, Tippett along with the ILM crew developed the Dinosaur Inpu Device (DID). The DID is an articulate dinosaur model with motion sensors attached to its limbs. A the traditional stop-motion animators moved the model, the movement was sent to the computer an recorded. This animation was then touched up and refined by the ILM animators until it was perfec Eventually 15 shots were done with the DID and 35 shots were done using traditional computer graphics methods.

The animators at ILM worked closely with Stan Winston, using his dinosaur designs so the CGI dinosaurs would match the large full-scale models Winston was creating. Alias Power Animator w: used to model the dinosaurs, and the animation was created using Softimage software. The dinosau skins were created using hand-painted texture maps along with custom Renderman surface shaders The final scene which is a show-down between the T-Rex and the Velociraptors was added at the last minute by Spielberg since he could see that ILM's graphics would produce a realistic sequence The results were spectacular and earned ILM another Special Effects Oscar in March of 1994.

In February 1994, Microsoft Corporation acquired Softimage for 130 million dollars. Microsoft's initial use of TDI technology will be internal, to enhance their multimedia CD-ROM products and interactive TV programs. Microsoft also plans to port the Softimage software over to its Windows NT operating system. This may be the first move in starting a trend for the shifting of high-end graphics software from workstations to personal computers.

The summer of 1994 featured blockbusters full of computer graphics. Some effects however, were so photorealistic that the computer's role was undetectable. For example in the movie "Forrest Gump," artists at ILM used digital compositing, overlaying different video sequences on top of eac other, to give the illusion that the actor Tom Hanks was in the same scene as some famous America politicians like John F. Kennedy. They also used standard image editing techniques to "cut" the leg off of an actor who played the part of a wounded solider who lost his legs in war. They simply hac him wear knee-high blue tube socks. Then after the film was scanned into the computer, the artists used Parallax software to copy portions of the background over the blue tube socks in every frame. The result is that Tom Hanks picks the actor up off a bed and it looks as if the actor really has no legs.

Another major project for ILM was the movie, "The Mask." In this movie, the computer graphics artist at ILM had full creative freedom in producing wild and extravagant personalities for the character of the Mask. In one case, they digitally removed his head and replaced it with the head of computer generated wolf. In another scene, they animated a massive cartoon style gun that the Mas pulls on a couple of criminals. This gun has multiple barrels, swinging chains of machine gun

bullets, even a guided missile with a radar locks on the criminals. All of it was created photorealistically using 3D graphics and then composited onto the live action shot.

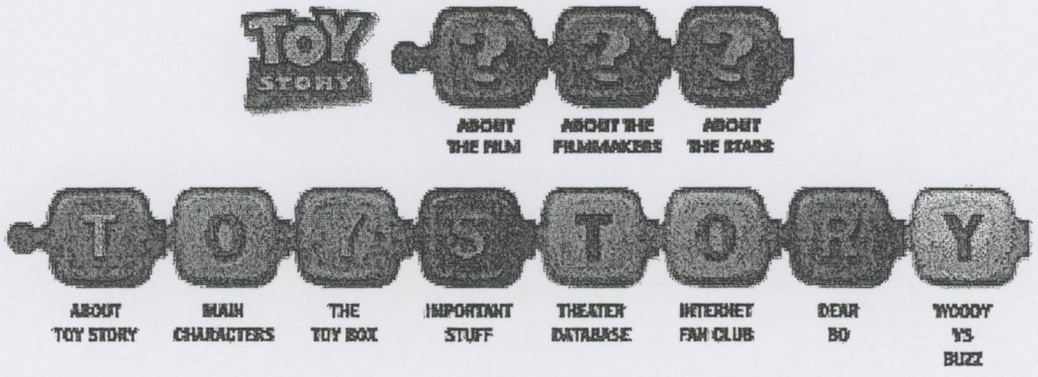
Considering the quality and realism that we see in computer graphics today, it's hard to imagine tha the field didn't even exist just 30 years ago. Yet even today the SIGGRAPH, the conference and exposition, continues to excite the computer graphics community with new graphics techniques. A while companies and have come and gone over the years, the people haven't. Most of the early pioneers are still active in the industry and just as enthusiastic about the technology as they were when they first started. Most of these pioneers that were discussed can be readily reached on the Internet or by simply calling the companies they work for. This access is similar to being an artist and being able to pick up the phone and call Monet, Michelangelo, Renoir, or Rembrandt.

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The 1970s saw the introduction of computer graphics in the world of television. Computer Image Corporation (CIC) developed complex hardware and software systems such as ANIMAC, SCANIMATE and CAESAR. All of these systems worked by scanning in existing artwork, then manipulating it, making it squash, stretch, spin, fly around the screen, etc. . . Bell Telephone and CBS Sports were among the many who made use of the new computer graphics.

While flat shading can make an object look as if it's solid, the sharp edges of the polygons can detract from the realism of the image. While you can create smaller polygons (which also means more polygons), this increases the complexity of the scene, which in turn slows down the performance of the computer rendering the scene. To solve this, a Henri Gouraud in 1971 presente a method for creating the appearance of a curved surface by interpolating the color across the polygons. This method of shading a 3D object has since come to be known as Gouraud shading. One of the most impressive aspects of Gouraud shading is that it hardly takes any more computations than Flat shading, yet provides a dramatic increase in rendering quality. One thing tha Gouraud shading can't fix is the visible edge of the object. The original flat polygons making up th torus are still visible along the edges of the object.

One of the most important advancements to computer graphics appeared on the scene in 1971, the microprocessor. Using Integrated Circuit technology developed in 1959, the electronics of a computer processor were miniaturized down to a single chip, the microprocessor, sometimes called CPU (Central Processing Unit). One of the first desktop microcomputers designed for personal use was the Altair 8800 from Micro Instrumentation Telemetry Systems (MITS). Coming through mail-order in kit form, the Altair (named after a planet in the popular Star Trek series) retailed for around $400. Later personal computers would advance to the point where film-quality computer graphics could be created on them.

In that same year, Nolan Kay Bushnell along with a friend formed Atari. He would go on to create an arcade video game called Pong in 1972 and start an industry that continues even today to be one of the largest users of computer graphics technology.

In the 1970's a number of animation houses were formed. In Culver City, California, Information International Incorporated (better known as Triple I) formed a motion picture computer graphics department. In San Rafael, California, George Lucas formed Lucasfilm. In Los Angeles, Robert Abel & Associates and Digital Effects were formed. In Elmsford, New York, MAGI was formed. In London, England, Systems Simulation Ltd. was formed. Of all these companies, almost none of them would still be in business ten years later. At Abel & Associates, Robert Abel hired Richard Edlund to help with computer motion control of cameras. Edlund would later get recruited to Lucasfilm to work on Star Wars, and eventually to establish Boss Film Studios creating special effects for movies and motion pictures and winning four Academy Awards.

In 1970 Gary Demos was a senior at Caltech when we saw the work of John Whitney Sr. This immediately developed an interest in him for computer graphics. This interest was further develope when he saw work done at Evans & Sutherland, along with the animation that was coming out of t University of Utah. So in 1972 Demos went to work for E&S. At that time they used Digital PDP-11 computers along with the custom built hardware that E&S was becoming famous for. The systems included the Picture System that featured a graphics tablet and color frame buffer (originall designed by UU).

It was at E&S that Demos met John Whitney Jr., the son of the original graphics pioneer. E&S started to work on some joint projects with Triple I. Founded in 1962, Triple I was in the business of creating digital scanners and other image processing equipment. Between E&S and Triple I there was a Picture Design Group. After working on a few joint projects between E&S and Triple I, Demos and Whitney left E&S to join Triple I and form the Motion Picture Products group in late 1974. At Triple I, they used PDP-10s and a Foonley Machine (which was a custom PDP-10). They developed another frame buffer that used 1000 lines; they also built custom film recorders and scanners along with custom graphics processors, image accelerators and the software to run it. Thi development led to the first use of computer graphics for motion pictures in 1973 when Whitney ar Demos worked on the motion picture "Westworld". They used a technique called pixellization whic is a computerized mosaic created by breaking up a picture into large color blocks. This is done by dividing up the picture into square areas, and then averaging the colors into one color within that area.

In 1973 the Association of Computing Machinery's (ACM) Special Interest Group on Computer Graphics (SIGGRAPH) held its first conference. Solely devoted to computer graphics, the convention attracted about 1,200 people and was held in a small auditorium. Since the 1960's the University of Utah had been the focal point for research on 3D computer graphics and algorithms. For the research, the classes set up various 3D models such as a VW Beetle, a human face, and the most popular, a teapot. It was in 1975 that a M. Newell developed the Utah teapot, and throughout the history of 3D computer graphics it has served as a benchmark, and today it's almost an icon for 3D computer graphics. The original teapot that Newell based his computer model on can be seen at the Boston Computer Museum displayed next to a computer rendering of it.

Ed Catmull received his Ph. D. in computer science in 1974 and his thesis covered Texture Mapping, Z-Buffer and rendering curved surfaces. Texture mapping brought computer graphics to new level of realism. Catmull had come up with the idea of texture mapping while sitting in his car a parking lot at UU and talking to another student, Lance Williams, about creating a 3D castle. Mos objects in real life have very rich and detailed surfaces, such as the stones of a castle wall, the material on a sofa, the wallpaper on a wall, the wood veneer on a kitchen table. Catmull realized tha if you could apply patterns and textures to real-life objects, you could do the same for their comput counterparts. Texture mapping is the method of taking a flat 2D image of what an object's surface looks like, and then applying that flat image to a 3D computer generated object. Much in the same

way that you would hang wallpaper on a blank wall.

The z-buffer aided the process of hidden surface removal by using zels which are similar to pixels but instead of recording the luminance of a specific point in an image, they record the depth of that point. The letter "z" reflecting the depth (as does Y for vertical position and X for horizontal position). The z-buffer was then an area of memory devoted to holding the depth data for every pix in an image. Today high-performance graphics workstations have a z-buffer built-in.

While Gouraud shading was a great improvement over Flat shading, it still had a few problems as t its realism. If you look closely at the Gouraud shaded torus you will notice slight variations in the shading that reveal the underlying polygons. These variations can also cause reflections to appear incorrectly or even disappear altogether in certain circumstances.

This was corrected however by Phong Bui-Toung, a programmer at the UU (of course). Bui-Toun arrived at UU in 1971 and in 1974 he developed a new shading method that came to be known as Phong shading. After UU, Bui-Toung went on to Stanford as a professor, and early in 1975 he die of cancer. His shading method accurately interpolates the colors over a polygonal surface giving accurate reflective highlights and shading. The drawback to this is that Phong shading can be up to 100 times slower than Gouraud shading. Because of this, even today, when animators are creating small, flat 3D objects that are not central to the animation, they will use Gouraud shading on them instead of Phong. As with Gouraud shading, Phong shading cannot smooth over the outer edges o 3D objects.

A major breakthrough in simulating realism began in 1975 when the French mathematician, Dr. Benoit Mandelbrot published a paper called "A Theory of Fractal Sets." After some 20 years of research he published his findings and named them Fractal Geometry. To understand what a fractal is, consider that a straight line is a one-dimensional object, while a plane is a two-dimensional object. However, if the line curves around in such a way as to cover the entire surface of the plane, then it is no longer one dimensional, yet not quite two dimensional. Mandelbrot described it as a fractional dimension, between one and two.

To understand how this helps computer graphics, imagine creating a random mountain terrain. You may start with a flat plane, then tell the computer to divide the plane into four equal parts. Next the new center point is offset vertically some random amount. Following that, one of the new smaller squares is chosen, subdivided, with its center slightly off-set randomly. The process continues recursively until some limit is reached and all the squares are off-set.

Mandelbrot followed up his paper with a book entitled "The Fractal Geometry of Nature." This showed how his fractal principles could be applied to computer imagery to create realistic simulations of natural phenomena such as mountains, coastlines, wood grain, etc.

After graduating in 1974 from UU, Ed Catmull went to a company called Applicon. It didn't last very long however, because in November of that same year he was made an offer he couldn't refuse. Alexander Schure, founder of New York Institute of Technology (NYIT), had gone to the UU to see their computer graphics lab. Schure had a great interest in animation and had already established a traditional animation facility at NYIT. After seeing the setup at UU, he asked Evans what equipment he needed to create computer graphics. He told his people to "get me one of everything they have." The timing happened to be just right because UU was running out of fundir at the time. Schure made Ed Catmull Director of NYIT's new Computer Graphics Lab. Then other talented people in the computer graphics field such as Malcolm Blanchard, Garland Stern and Lanc Williams left UU and went to NYIT. Thus the leading center for computer graphics research soon switched from UU to NYIT.

One talented recruit was Alvy Ray Smith. As a young student at New Mexico State University in 1964, he had used a computer to create a picture of an equiangular spiral for a Nimbus Weather satellite. Despite this early success, Smith didn't take an immediate interest in computer graphics. H moved on to Stanford University, got his Ph.D., then promptly took his first teaching job at New York University. Smith recalls, "My chairman, Herb Freeman, was very interested in computer graphics, some of his students had made important advances in the field. He knew I was an artist and yet he couldn't spark any interest on my part, I would tell him 'If you ever get color I'll get interested.' Then one day I met Dr. Richard Shoup, and he told me about Xerox PARC (Palo Alto Research Center). He was planning on going to PARC to create a program that emulated painting o a computer the way an artist would naturally paint on a canvas."

Shoup had become interested in computer graphics while he was at Carnegie Mellon University. H then became a resident scientist at PARC and began working on a program he called "SuperPaint." used one of the first color frame buffers ever built. At the same time Ken Knowlton at Bell Labs w creating his own paint program.

Smith on the other hand, wasn't thinking much about paint programs. In the meantime, he had broken his leg in a skiing accident and re-thought the path his life was taking. He decided to move back to California to teach at Berkeley in 1973. "I was basically a hippie, but one day I decided to visit my old friend, Shoup in Palo Alto. He wanted to show me his progress on the painting program, and I told him that I only had about an hour, and then I would need to get back to Berkeley. I was only visiting him as a friend, and yet when I saw what he had done with his paint program, I wound up staying for 12 hours! I knew from that moment on that computer graphics w what I wanted to do with my life." Smith managed to get himself hired by Xerox in 1974 and worked with Shoup in writing SuperPaint.

A few years later in 1975 in nearby San Jose, Alan Baum, a workmate of Steve Wozniak at Hewle Packard, invited Wozniak to a meeting of the local Homebrew Computer Club. Homebrew, started by Fred Moore and Gorden French, was a club of amateur computer enthusiasts, and it soon was a hotbed of ideas about building your own personal computers. From the Altair 8800 to TV typewriters, the club discussed and built virtually anything that resembled a computer. It was a friend at the Homebrew club that first gave Wozniak a box full of electronic parts and it wasn't lon before Wozniak was showing off his own personal computer/toy at the Homebrew meetings. A close friend of Wozniak, Steve Jobs, worked at Atari and help Wozniak develop his computer into the very first Apple computer. They built the units in a garage and sold them for $666.66.

In the same year William Gates III at the age of 19 dropped out of Harvard and along with his frien Paul Allen, founded a company called Microsoft. They wrote a version of the BASIC programmin language for the Altair 8800 and put it on the market. Some five years later in 1980, when IBM wa looking for an operating system to use with their new personal computer, they approached Microsc and Gates remembered an operating system for Intel 8080 microprocessors written by Seattle Computer Products (SCP) called 86-DOS. Taking a gamble, Gates bought 86-DOS from SCP for $50,000, rewrote it, named it DOS and licensed it (smartly retaining ownership) to IBM as the operating system for their first personal computer. Today Microsoft dominates the personal computer software industry with gross annual sales of almost 4 billion dollars, and now it has moved into the field of 3D computer graphics.

Meanwhile back at PARC, Xerox had decided to focus solely on black and white computer graphic dropping everything that was in color. So Alvy Ray Smith called Ed Catmull at NYIT and went ou east with David DiFrancesco to meet with Catmull. Everyone hit it off, so Smith made the move from Xerox over to NYIT; this was about two months after Catmull had gotten there. The first thin Smith did was write a full color (24-bit) paint program, the first of its kind.

Later others joined NYIT's computer graphics lab including Tom Duff, Paul Heckbert, Pat Hanrahan, Dick Lundin, Ned Greene, Jim Blinn, Rebecca Allen, Bill Maher, Jim Clark, Thaddeus

Beier, Malcom Blanchard and many others. In all, the computer graphics lab of NYIT would eventually be home to more than 60 employees. These individuals would continue to lead the field computer graphics some twenty years later. The first computer graphics application NYIT focused on was 2D animation and creating tools to assist traditional animators. One of the tools that Catmull built was "Tween," a tool that interpolated in-between frames from one line drawing to another. They also developed a scan-and-paint system for scanning and then painting pencil-drawn artwork. This would later evolve into Disney's CAPS (Computer Animation Production System).

Next the NYIT group branched into 3D computer graphics. Lance Williams wrote a story for a movie called "The Works," sold the idea to Schure, and this movie became NYIT's major project f over two years. A lot of time and resources were spent in creating 3D models and rendering test animations. "NYIT in itself was a significant event in the history of computer graphics" explains Alvy Ray Smith. "Here we had this wealthy man, having plenty of money and getting us whatever we needed, we didn't have a budget, we had no goals, we just stretched the envelope. It was such an incredible opportunity, every day someone was creating something new. None of us slept, it wa common to work 22 hour days. Everything you saw was something new. We blasted computer graphics into the world. It was like exploring a new continent."

However, the problem was that none of the people in the Computer Graphics Lab understood the scope of making a motion picture. "We were just a bunch of engineers in a little converted stable or Long Island, and we didn't know the first thing about making movies" said Beier (now technical director for Pacific Data Images). Gradually over a period of time, people became discouraged and left for other places. Smith continues, "It just wasn't happening. We all thought we would take par in making a movie. But at the time it would have been impossible with the speed of the computers. Alex Schure made an animated movie called "Tubby the Tuba" using conventional animation techniques, and it turned out to be very disappointing. "We realized then that he really didn't have what it takes to make a movie," explains Smith. Catmull agrees, "It was awful, it was terrible, half the audience fell asleep at the screening. We walked out of the screening room thinking 'Thank Go we didn't have anything to do with it, that computers were not used for anything in that movie!'" The time was ripe for George Lucas.

Lucas, with the success of Star Wars under his belt, was interested in using computer graphics on his next movie, "The Empire Strikes Back". So he contacted Triple I, who in turn produced a sequence that showed five X-Wing fighters flying in formation. However disagreements over financial aspects caused Lucas to drop it and go back to hand-made models.

The experience however showed that photorealistic computer imagery was a possibility, so Lucas decided to assemble his own Computer Graphics department within his special effects company, Lucasfilm. Lucas sent out a person to find the brightest minds in the world of Computer Graphics. He found NYIT. Initially the individual went to Carnegie Mellon University and talked to a professor who referred him to one of his students, **Ralph Guggenheim**, who referred him to Catmull at NYIT. After a few discussions, Catmull flew out to the west coast and met with Lucas and accepted his offer.

Initially only five from NYIT went with Catmull including Alvy Ray Smith, David DiFrancesco, Tom Duff and Ralph Guggenheim. Later however, others would take up the opportunity. Slowly t computer graphics lab started to fall apart and ceased to be the center of computer graphics researc The focus had shifted to Lucasfilm and a new graphics department at Cornell University. Over the next 15 years, Lucasfilm would be nominated for over 20 Academy Awards, wining 12 Oscars, fi Technical Achievement Awards and two Emmys.

Looking back at NYIT, Catmull reflects "Alex Schure funded five years of great research work, an he deserves credit for that. We published a lot of papers, and were very open about our research, allowing people to come on tours and see our work. However now there are a lot of lawsuits going on, mainly because we didn't patent very much. People then subsequently acquired patents on that

work and now we are called in frequently to show that we had done the work prior to other people

Catmull continues, "We really had a major group of talented people in the lab, and the whole purpose was to do research and development for animation. We were actually quite stable for a lon time, that first five years until I left. However, the primary issue was to make a feature film, and to do that you have to gather a lot of different kinds of skills; Artistic, Editorial, etc.. Unfortunately, t managers of the school did not understand this. They appreciated the technical capabilities. So as a group we where well taken care of, but we all recognized that in order to produce a feature film we had to have another kind of person there, movie people, and basically those people weren't brough into the school. We were doing the R & D but we just could not achieve our goals there. So when Lucas came along, and proved that he did have those kind of capabilities and said I want additional development in this area (of computer graphics), we jumped at it."

Thus in 1979 George Lucas formed the new computer graphics division of Lucasfilm to create computer imagery for motion pictures. Catmull became vice president and during the next six years this new group would assemble one of the most talented teams of artists and programmers in the computer graphics industry. The advent of Lucasfilm's computer graphics department is viewed by many as another major milestone in the history of computer graphics. Here the researchers had access to funds, but at the same time they were working under a serious movie maker with real, definite goals.

The ACM in 1976 allowed for the first time, exhibitors in the annual SIGGRAPH conference. This turned up 10 companies who exhibited their products. By 1993 this would grow to 275 companies with over 30,000 attendees.

Systems Simulation Ltd. (SSL) of London created an interesting computer graphics sequence for t movie "Alien" in 1976. The scene called for a computer-assisted landing sequence where the terrain was viewed as a 3D wireframe. Initially a polystyrene landscape was going to be digitized to create the terrain. However, the terrain needed to be very rugged & complex and would have made a huge database if digitized. Alan Sutcliffe of SSL decided to write a program to generate the mountains at random. The result was a very convincing mountain terrain displayed in wireframe with the hidden lines removed. This was typical of early efforts at using computer generated imagery (CGI) in motion pictures, using it to simulate advanced computers in Sci-Fi movies.

Meanwhile the Triple I team was busy in 1976 working on "Westworld's" sequel, "Futureworld." In this film, robot Samurai warriors needed to materialize into a vacuum chamber. To accomplish this, Triple I digitized still photographs of the warriors and then used some image processing techniques to manipulate the digitized images and make the warriors materialize over the background. Triple I developed some custom film scanners and recorders for working on films in high resolutions, up to 2,500 lines.

Also in that same year at the Jet Propulsion Laboratory in Pasadena, California (before going to NYIT), James Blinn developed a new technique similar to Texture Mapping. However, instead of simply mapping the colors from a 2D image onto a 3D object, the colors were used to make the surface appear as if it had a dent or a bulge. To do this, a monochrome image is used where the white areas of the image will appear as bulges and the black areas of the image will appear as dents Any shades of gray are treated as smaller bumps or bulges depending on how dark or how light the shade of gray is. This form of mapping is called Bump Mapping.

Bump maps can add a new level of realism to 3D graphics by simulating a rough surface. When bo a texture map and a bump map are applied at the same time, the result can be very convincing. Without bump maps, a 3D object can look very flat and un-interesting.

Busy Blinn also published a paper in that same year on creating surfaces that reflect their surroundings. This is accomplished by rendering six different views from the location of the object (top, bottom, front, back, left and right). Those views are then applied to the outside of the object i a way similar to standard texture mapping. The result is that an object appears to reflect its surroundings. This type of mapping is called environment mapping.

In December of 1977, a new magazine debuted called Computer Graphics World. Back then the major stories involving computer graphics revolved around 2D drafting, remote sensing, IC desigr military simulation, medical imaging and business graphics. Today, some 17 years later, CGW continues to be the primary medium for computer graphics related news and reviews. Computer graphics hardware was still prohibitively expensive at this time. The National Institute of Health pa 65,000 dollars for their first frame buffer back in 1977. It had a resolution of 512x512 with 8 bits (color depth. Today a video adapter with the same capabilities can be purchased for under 100 dollars.

During the late 1970's Don Greenberg at Cornell University created a computer graphics lab that produced new methods of simulating realistic surfaces. Rob Cook at Cornell realized that the lightii model everyone had been using best approximated plastic. Cook wanted to create a new lighting model that allowed computers to simulate objects like polished metal. This new model takes into account the energy of the light source rather than the light's intensity or brightness.

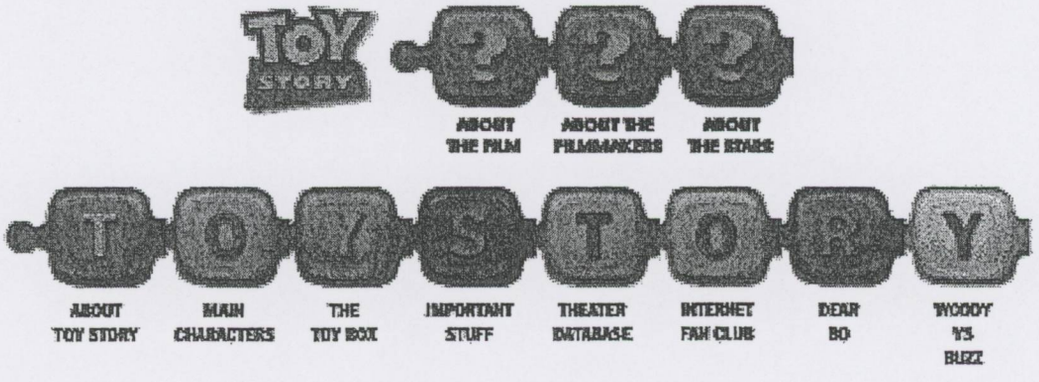
As the second decade of computer graphics drew to a close the industry was showing tremendous growth. In 1979, IBM released its 3279 color terminal and within 9 months over 10,000 orders ha been placed for it. By 1980, the entire value of all the computer graphics systems, hardware, and services would reach a billion dollars.

Introduction

Pixar | Disney | Toy Story | Beauty and the Beast

Ed Catmull | Ralph Guggenheim | John Lasseter | William Reeves | Renderman

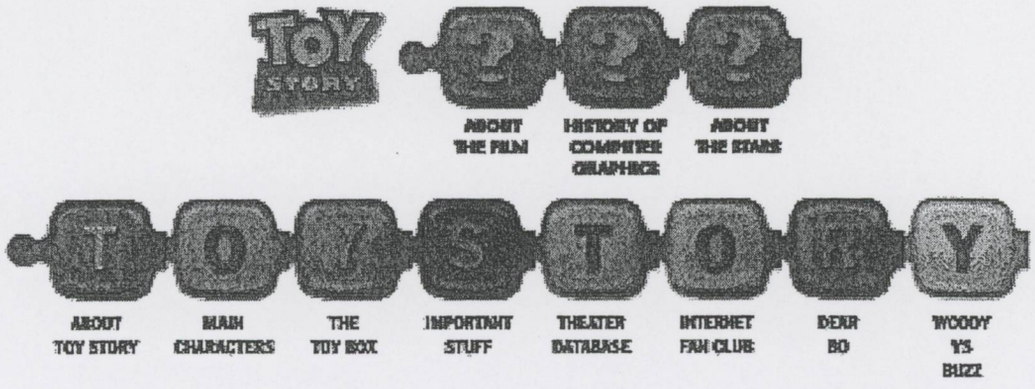
Advances of the 1960s | Advances of the 1980s | Advances of the 1990s



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"Toy Story" was written by Joss Whedon ("Speed," "Buffy the Vampire Slayer"), Andrew Stanto
Joel Cohen and Alex Sokolow.

Go To Randy Newman/Toy Story Music Page



Comments? Email the Webmaster at andys-room@www.toystory.com.
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IMPORTANT STUFF



IMPORTANT STUFF

Want to know where you can find "Toy Story" merchandise? Find out when and where to tune for a television special all about the movie? Chec out a hot 3-D video game based on "Toy Story"' Read about the musical score? Take a quick tour of the incredible "Totally Toy Story"? Then you've come to the right place! Here's where you'll find all this Important Stuff and more. Ju: click on the hypertext and buttons below to go t(those sections. And don't forget your AA's!

Toy Story TV Special | Promotional Partners | Toy Story Music | 3-D Video Game

TV SPECIAL - A LOOK BEHIND THE SCENES OF "TOY STORY"

For a behind-the-scenes look at the amazing people and powerful computer techniques that made "Toy Story" - be sure to watch "The Making of 'Toy Story' - To Infinity and Beyond" on the Disn(Channel. You'll see clips from the film, examples of early computer animation and interviews with the voices behind the toys including Tom Hanks, Tim Allen, Annie Potts, Wallace Shawn, John Raztenberger, Jim Varney and Don Rickles. See for yourself how animators like Peter Docter figur out how the Green Army Men walk, and discover how John Lasseter found inspiration for many o "Toy Story's" characters from his own childhood toys.

If you don't have the Disney Channel, but still want to see how Pixar and Walt Disney Pictures made toys come to life, tune in to the Disney Channel's free preview on Thursday, November 30th

Airdates:
Sunday, November 26 / 8:30 pm
Thursday, November 30 / 8:00 pm
Sunday, December 10 / 11:30 am

PROMOTIONAL PARTNERS

Burger King®

Beginning November, you'll be able to start filling your own toy box at Burger King. Six different "Toy Story" characters - Buzz Lightyear, Woody, Mr. Potato Head, Rex, R.C. Car and the Green Army Men - will be available with all Kids Club Meals. "Toy Story" will also be featured in the Ki Club newsletter distributed in restaurants. Burger King will also offer a series of four collector plus puppets of Buzz, Woody, Rex and Hamm with the purchase of a Burger King Value Meal.

Frito Lay

When you see a six-foot tall Woody or Buzz Lightyear in the supermarket in November, don't be alarmed. They'll be accompanied by the full line of Frito-Lay products. Each bag will have a mail-i rebate offer on the purchase of "Toy Story" merchandise, including the video game, soundtrack, action figures and storybooks.

Minute Maid

If you're aching for a squeeze bottle with Woody or Buzz Lightyear, look no further. You'll be abl to send away for them or product coupons when you purchase Minute Maid products. Minute Maic will also be offering a sweepstakes awarding prizes for trips to Walt Disney World or cash to buy toys with.

Nestle®

Unwrap a Nestle candy bar and you'll soon see more than just great chocolate. Seven character-themed scenes from the movie will appear etched in king-size chocolate bars, as well as new "Toy Story" mini-bars featuring characters, too.

Payless ShoeSource®

When you shop at Payless ShoeSource, you'll receive more than just the right shoe and the left shoe. You'll also find a Story and Savings Booklet full of added-value discount offers in your bag.

"TOY STORY" SOUNDTRACK

The talents of Grammy Award-winning composer/songwriter Randy Newman are showcased on Walt Disney Records' soundtrack to Disney's upcoming animated film, Toy Story. With three brand-new songs written and performed by Newman, the soundtrack features a musical style that's as quirky, heartwarming and hilarious as the film itself. Toy Story releases October 31.

The Toy Story soundtrack includes the endearing buddy song "You've Got a Friend in Me," an all-new duet performed by Newman and Grammy-Award winning recording artist Lyle Lovett. In addition to the musical score, the soundtrack includes two other songs by Newman, "And I Will G Sailing No More" and "Strange Things."

"TOY STORY" 3-D VIDEO GAME

Disney Interactive will give video gamers a chance to experience the magic and thrill of "Toy Story on their own with the release of the "Toy Story" video game.

The game showcases the same incredible 3-D computer animation Disney will debut in the "Toy Story" movie -- along with a non-stop "laughs and action" game format inspired by the movie. "To Story" delivers a unique and challenging adventure that expands the limits of video game technolog and entertainment.

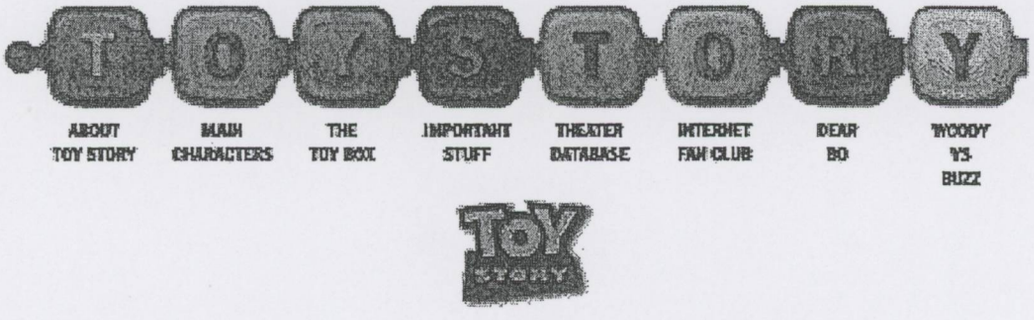
Utilizing groundbreaking programming techniques and multiple software development tools (engines), the "Toy Story" video game offers incredible next-generation quality graphics. These game graphics are enhanced even more by the same team of acclaimed Pixar artists and animation specialists that worked on the development of the movie.

Pixar's unique, three-dimensional animation technology is used to create the most incredible, larger-than-life character sprites ever seen on a 16-bit platform. The sprites are then played against a variety of 3-D game environments -- including the PizzaPlanet fast food arcade, the spaceship-shaped Claw Machine, and the toy-torturing neighbor kid's workbench.

In the game, Woody uses his pull-string lasso to clear a safe path and lead an elite commando team of army men and other colorful characters to safety. Later, in a toy world gone mad, Woody becomes an out-of-control rodeo rider maneuvering through a sea of hostile toys atop a panic-stricken Tyrannosaurus Rex. In another scenario, Woody and Buzz maneuver a careening radio-controlled car in a fast-paced obstacle chase.

The challenging, vibrantly animated and always comical scenarios Woody and Buzz face during the wacky journey to the outside world provide hours of sidesplitting action gameplay enhanced by incredible "see-it-to-believe-it" graphics.

The "Toy Story" video game will be available on Sega Genesis® and Nintendo Super NES® platforms on November 21. Both versions will be sold at a variety of retail outlets including toy stores, mass merchandisers, computer superstores and software boutiques.



Comments? Email the Webmaster at andys-room@www.toystory.com.

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Steven P. Jobs

Pixar Animation Studios

Office of the President, Chairman and Chief Executive Officer

---

NeXT Computer Inc.

Chairman and CEO

I. Personal Information

Educational Background

Mr. Jobs attended Reed College in Portland, Oregon.

Career History

Mr. Jobs is the founder of Pixar and has served in the Office of the President since February 1995, as its Chairman since March 1991, and as its Chief Executive Officer since February 1986. He has been a director of Pixar since February 1986 and served as Chairman from February 1986 to November 1988. Although Mr. Jobs spends approximately half of his time at Pixar and is active in Pixar's management, he is not committed to spend a certain amount of time at Pixar nor is he able t devote his full time and resources to Pixar.

In September of 1985 Mr. Jobs co-founded NeXT Computer Inc., which develops and markets object-oriented software for client/server business applications. He currently divides his time between NeXT and Pixar.

Mr. Jobs was also a co-founder of Apple Computer, Inc., where he co-designed the Apple II and l

the development, manufacturing and marketing of the Macintosh and LaserWriter printer.

Miscellaneous

Steven P. Jobs is 40 years of age according to information dated September 30, 1995.

Mr. Jobs was awarded the National Technology Medal in 1985, the Jefferson Award for Public Service in 1987 and was named Entrepreneur of the Decade by Inc. magazine.

II. Financial Information

Cash Compensation

Pixar 1994 Annual Compensation -- $0

Stock Holdings

COMPANY NAME	PERCENT	SHARES (date)	PRICE (date)
Pixar	80.2%	30,000,000 (9/30/95)	$28.50 (12/5/95)

The current calculated value of Mr. Jobs' Pixar holdings is $855,000,000

As part of the Initial Public Offering (11/29/95) Mr. Jobs did not file to sell any of his shares.

Options

As of September 30, 1995, Mr. Jobs had options to purchase 2,038,000 shares of Pixar's Commo Stock that were currently exercisable.

Certain Transactions

Mr. Jobs provided capital contributions (which are classified as equity) to Pixar of $2,200,000, $1,290,000 and $1,850,000 in cash during 1992, 1993 and 1994, respectively.

III. Company Information

Pixar Animation Studios (NASDAQ: PIXR)
1001 West Cutting Boulevard
Richmond, CA 94804
(510) 236-4000

Summary

Pixar is a digital animation studio with the technical, creative and production capabilities to create a new generation of animated feature films, CD-ROM titles and related products. Pixar's objective is to develop computer animated feature films with a new three-dimensional appearance, memorable characters and heartwarming stories that will appeal to audiences of all ages. The first such film, Tc Story, was created and produced by Pixar and is being distributed by The Walt Disney Company. Pixar believes that consumer marketing campaigns surrounding the theatrical release of such films can generate broad consumer awareness of the films, which in turn can drive box office demand as well as sales of film-related products, such as home videos, CD-ROM titles, direct-to-video sequel sound-tracks, toys and other merchandise.

Of the 140 employees that Pixar employed as of September 30, 1995, 17 were in television commercial production, 23 were in feature film production, 4 were in sales, marketing and technica support, 19 were in general management, administration and finance and 77 were in research and development (of whom approximately 22 were working on CD-ROM products, approximately 24 were working on research and development projects and approximately 31 were working on CD-ROM and other projects but are expected to transition back to feature film production). Althoug none of Pixar's employees is represented by a labor union, it is common for animators and actors a film production companies to belong to a union, and there can be no assurance that Pixar's employees will not join or form a labor union or that Pixar, for certain purposes, will not be require to become a union signatory. Pixar has not experienced any work stoppages and considers its relations with the employees to be good.

Competition

Pixar's animated feature films will compete with feature films and other family oriented entertainment products produced by major movie studios, including Disney, Turner Broadcasting Systems Inc., Warner Bros. Inc. (which has announced its intention to acquire Turner Broadcastin Systems Inc.), Twentieth Century Fox Film Corporation, Paramount Pictures, Columbia/Tri-Star Pictures Inc., Lucasfilm, Universal City Studios, Inc. and MGM/UA, as well as numerous other independent motion picture production companies.

Pixar also expects to compete with computer graphics special effects firms, including ILM, Digital Domain, Pacific Data Images, Rhythm & Hues and Boss Film Studios, Inc. These computer graphics special effects firms may be capable of creating their own three-dimensional computer animated feature films or may produce three-dimensional computer animated feature films for movi studios that compete with Pixar. ILM has already created and produced three-dimensional character animation which was used for the ghosts in the live action film Casper. These firms are also expected to compete with Pixar for special effects work should Pixar choose to pursue that type of work.

Pixar also expects to compete to the same extent with other CD-ROM publishers, television commercial studios and software publishers.

IV. Recent News

Knight-Ridder/Tribune Business News

Business Week: October 30, 1995

OUT OF THE INKLESS WELL In Toy Story, Disney's characters were "drawn" by computer

They may be mere cartoons to the rest of the world. But to Walt Disney Co., its animated films are money machines, producing billions in revenues in recent years. With the rush of new cash, however, the salaries of animators have soared. Little wonder, then, that Disney executives seem pleased by Toy Story, which they are trumpeting as Hollywood's first computer-animated movie.

The economics of Toy Story, which will hit movie theaters on Nov. 12, are compelling. Produced rows of Silicon Graphics Inc. workstations at Steven P. Jobs's Pixar animation studio outside San Francisco, the 3-D-like film that brings to life toys in a little boy's room was made with just 27 animators vs. the 70 or so who inked Pocahontas. With animators making $100,000-plus a year, that amounts to savings of more than $10 million, which helped Disney hold the film's budget to a estimated $30 million.

The question now is whether Toy Story will do better than 1993's The Nightmare Before Christma Disney's lackluster first attempt at making an animated film without pencils and paint. Like Disney. Apple Computer founder Jobs, who bought Pixar from filmmaker George Lucas in 1985 for $10 million, has a lot riding on the answer: He filed an initial stock offering on Oct. 10 to sell 16% of Pixar for up to $82 million.

Given the dearth of alternatives, kids and their parents may warm to Toy Story's rounded computer images. It features a pull-toy cowboy, whose voice is supplied by Tom Hanks, and Tim Allen giving voice to a plastic spaceman called Buzz Lightyear. To appeal to parents, it also is laced with jokes aimed at adults. (A plastic dinosaur announces he came from "an LBO that was bought by Mattel.")

Still, this film has some shortcomings. The Lion King and other recent Disney hits were packed wi Broadway-quality songs; Toy Story has three forgettable numbers by singer-songwriter Randy Newman. It's also loaded with well-known toys such as Playskool's Mr. Potato Head and Ohio A Co.'s Etch-a-Sketch, so only two Toy Story characters have been licensed.

Disney already is gearing up its formidable marketing machine to create a buzz around the new flicl Among the strategies: a Toy Story parade at Walt Disney World in Orlando, Florida, a Disney Channel special, and advertisements for Toy Story leading off the 7 million Cinderella video cassettes it has shipped. There will be plenty of cross-promotions, too--$125 million worth, Disne says. Among them: giveaways by Minute Maid orange juice, Burger King, and Frito-Lay. In L.A. Disney even has put $1.3 million into a new funhouse featuring rides and shows based on the movie.

More projects are in the works if Toy Story succeeds. Disney plans to release a pair of CD-ROM games and is contemplating an animated TV show based on the movie. And Pixar, which has a dea to produce two more films for Disney, is working on a second film about insects called Bugs. Quit a brouhaha over a pack of computer-generated toys.

* * *

MOUNTAIN VIEW, CALIF. (Nov. 30, 1995) BUSINESS WIRE -Nov. 30, 1995--The making c "Toy Story," the stunning new movie from Walt Disney Pictures that is the world's first full-length

studio that relies on computers rather than cameras to make movies. "Toy Story," which was Pixar first full-length computer-animated effort, was the top box-office draw last weekend, grossing $38 million.

Walt Disney Co., which is distributing "Toy Story", has also hired Pixar to create two other movie

The success of "Toy Story" is spreading beyond the movie theaters. Toys related to the movie are already on sale for the Christmas season. And a CD-ROM version of the movie is in the works for next Christmas.

Silicon Valley industry watchers said Jobs' financial reward - even if it turns out to be fleeting - wa well deserved, since he held onto his Pixar investment through a difficult decade.

When Jobs first bought Pixar, the company was a manufacturer of specialized high-end graphics computers and software. Only in recent years has he transformed it into a digital movie production company, following the original vision of Pixar's founders, a small group of computer researchers who were pioneers in computer animation.

Jobs contended Wednesday that the money did not mean much to him. Instead, he said he was muc more ecstatic that the movie was getting widespread positive reviews.

"There's no yacht in my future," Jobs said. "I've never done this for the money, but I'm grateful that people are believing in our dream and the reality of our achievements."

At Apple Computer, Jobs and Wozniak each initially had 8.3 million shares that were worth $28.7 apiece on Dec. 13, 1980, the first day Apple's shares were traded. That gave Jobs, who was then 2 years old, a worth on paper of $239 million.

Apple's stock peaked in 1987 at $82.25. At that point, Jobs' original shares would have been wort $683 million. But after losing a bitter battle for control of Apple in 1985, Jobs quit and then quickly sold out while Apple's shares were trading below their initial offering price.

Industry executives have estimated that he left the company with about $100 million.

Wednesday, at the close of trading, Jobs' 30 million Pixar shares were worth $1.17 billion on paper. Of course, there is no guarantee that Pixar's shares will continue to trade as high as $39.

"The future value of Pixar is a very simple function of their ability to produce another great movie," said Roger McNamee, general partner of Integral Partners, a Menlo Park, Calif., technology investment firm.

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wrinkle 2 (fine)

- Most time spent on most inconsequential item: 15 hours on hardwood floor scratches
- Most time spent on smallest pixel object: 8 hours on 4x4 pixel red laser dot that Buzz is supposed to project on Woody.

Shading

- We are writing 1300 "shaders" for Toy Story
- Approximately 2000 texture maps are used in the film. Most are painted digitally, but som are photographed and scanned. Wallpaper patterns, for example, are created by replicating graphic elements painted in the art department.
- The human skin shader is one of the more complex surface appearances. Up to 10 separat texture maps are applied to each patch of skin, controlling such detail as freckles, blushing facial hair, oil layer and wrinkles.
- Sid's desk also uses a variety of textures to give the appearance of a wooden board underneath, once painted but now chipping away, covered with spills and dents.
- The shade that took the longest time to complete, beginning to end: Andy's hair, about 9 months.
- Tia's favorite texture map: Sid's bed pee stain and Sid's desk.
- Bill's favorite texture map: Dirt and color roughs for Pizza Planet
- Robin's favorite texture map: Displacement and textures for Pterodactyl
- There are 32 different buildings designed for the film, not including the Walt Disney castle in the opening shot.
- Figure that each building has four sides and a roof. Figure an average of 4 layers per side (not counting the roof) and you get 17 x 32 = 544 elements that were created for the building textures.

Inside Jokes in "Toy Story"

- Watch the industrial graphics on the gas pumps and oil cans - they have secret messages i them.
- Keep an eye on the fictitious business names with film crew members and their loved one Do the same with the book titles in Andy and Sid's rooms.

Facts For Car Fans

- 8 different body styles
- 12 different colors
- 36 different cars in the film, not including 4 specialized cars and trucks
- There are four different hubcap patterns
- Each car has dirt on at least 5 sides
- 48 separate dirt paintings for the misc. cars
- 21 different license plates all of which have special meaning for crew members

Lighting

- Largest number of lights in any shot: 32
- Smallest number of lights in any shot: 6
- Most obscure lighting effect: Potato Head's ears (5 individual lights that shine only on his ears)
- There are special controls to place the reflections on Bo Peep's glazed surfaces and Buzz's helmet

Technical Rendering

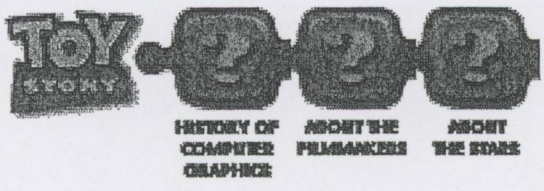
- The rendering software devotes approximately 1/2 million basic arithmetic operations (add multiply, test, move, etc.) to each pixel.
- On the movie screen, a pixel is a square about 1/4 inch on a side
- The film frames total 160 billion pixels, 600 billion bytes, or 1200 CD-ROMs full of data (uncompressed). That's a stack over 3 feet high of just CD-ROMs, without the boxes
- Approximately 34 terabytes of RenderMan files needed to be sent through the renderer before the end of this production
- Rendering survey for one representative 5-day period:
  Longest render: 14.3 hours
  Shortest: 5 seconds
  Average: 1.23 hours
- Total storage required to store all final frames: over 500 Gigabytes
- Total storage required for all film information: 2 Terabytes or 2 trillion bytes of data

Editorial

- 2 Electronic editing systems
- Total hard drive storage approximately for both picture and sound in editorial: 54 Gigs
- The first feature film in animation to produce all imagery and shoot to film as the final step in the process

Film

- It's interesting to note that amongst all this application of high technology, we implement some of it to shoot our polys (pencil tests) on a Kodak camera that was built on September 17, 1912. You read that right, 1912.



TOY STORY FACT SHEET

Technical Accomplishments

- 79 minutes of computer animation
- 114,240 frames of computer animation
- 1635 completed shots in the film
- More than 400 models used
- Over 800,000 machine hours to render final elements
- Maximum weekly output for crew - 3.5 minutes of completed animation

Wisdom on "Woody"

- Woody is described by 52,865 lines of model program
- There are 712 animation controls on Woody, 212 in his face and 58 in Woody's mouth alone
- 26 texture maps counting dirt maps that put dirt on his face and hands

The Buzz on "Buzz"

- Buzz is described by 34,846 lines of model program
- There are around 700 separate animation controls on Buzz
- He has 10 built in lights
- He has 189 separate texture maps on him when he's not dirty
- In the sequences when he's scuffed and dirty, he has an additional 45 texture maps describing the dirt

Storyboards

- Storyboard drawings are the blueprint for the movie
- Total number of storyboards for the project = 25,000 drawings

Modeling

- All the models for the film comprise 4.5 million lines of code -- that's 270 mega (million) bytes
- 366 objects modeled over 2 years by a total of 22 technical directors
- Of those objects, 76 were characters
- The modeling took over 10 man years to complete
- Andy's Hairs: 12,384
- Sid's Hairs: 15,977
- There are 128 animation controls on Sid's backpack

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December 1, 1995 - N.Y. Times News Service

SAN FRANCISCO - In the world of high technology, which keeps score in part by tracking the up and downs of the stock market, Steven Jobs, the co-founder of Apple Computer, re-emerged Wednesday as a captain of industry.

Jobs' company, Pixar Animation Studios, the maker of the blockbuster movie "Toy Story," offered its stock to the public Wednesday, and by the end of trading the shares had almost doubled in value.

As such, the Silicon Valley entrepreneur's remaining Pixar stake of 80.2 percent was worth more than $1 billion on paper - more than the value of his Apple stock at any time during the eight years he ran that company.

With his gains, Jobs joins the ranks of new technology billionaires in just one day.

Jobs invested $60 million and spent nine years waiting for his payoff, but his story does have more mythic overtones for the computer industry.

Jobs, 40, has long been a mercurial figure in Silicon Valley's hot-house culture, which values entrepreneurs with vision and personal drive - but which also sees most of its start-up ventures end in failure.

With Stephen Wozniak, Jobs founded Apple in a Cupertino, California garage in 1976. By the early 1980s, Jobs had risen to international prominence as the personal computer began to transform American society.

But that was not to last. In 1985, he was driven from Apple by John Sculley, who Jobs had hired several years earlier as Apple's president. The following year, Jobs started NeXT Inc., which has tried with little success to compete with Apple. As such, Jobs had largely fallen out of the industry limelight in recent years.

It was almost as a footnote that Jobs bought Pixar, a tiny computer company specializing in ultra-high-resolution computer animation technology, from Lucas Film for $60 million in 1986.

But Wednesday, that footnote came to symbolize the long-heralded convergence of Hollywood and Silicon Valley.

Pixar's stock was initially priced at $22 a share on Tuesday by the underwriters taking it to the public market. That meant Jobs' stake was already worth on paper $660 million - assuming the stock offering was successful.

Pixar's shares shot up to $45.50 during their first hour of trading Wednesday on the NASDAQ market. Trading had to be delayed because there were too many orders to buy and not enough sellers. The stock eventually traded as high as $49.50 before falling back to close at $39 in trading 4.8 million shares.

Pixar, which is based in Richmond, Calif., across the bay from San Francisco, is a digital animatic