PIXAR

THE COMPANY AND ITS FOUNDERS

by A. M. Buckley

TECHNOLOGY PIONEERS

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John Lasseter uses a graphics tablet to draw in a computer program.

THE MAKING OF *LUXO JR.*

In 1986, John Lasseter, a former Disney animator, sat at his desk in the new Pixar Animation Studios office. At that time, computer graphics for digital animation was brand new. And Lasseter, now Pixar's chief creative officer, was Pixar's only animator.

Ed Catmull, scientist and cofounder of Pixar, had suggested they create a new character. Lasseter worked side by side with a team of computer engineers to develop the software and tools to create images and animate characters for each new film. But on that day, Lasseter was working alone at his desk, trying to imagine a new character for the Pixar team to animate.

Lasseter recalled, "I was sitting at the desk thinking and I just kept staring at this lamp." The lamp was made by Luxo, a well-known manufacturer of desk lamps with flexible stands. "I was like, [points at lamp], the classic Luxo lamp! I just started moving it around like it was alive."[1]

Lasseter and his team began digitally building the lamp. They made a digital model and played with its movements on screen. Lasseter said, "I love bringing inanimate objects to life and maintaining the integrity of the object, pulling personality and movement and physics out of that."[2]

The characters that developed were Luxo Sr. and Luxo Jr., a father-and-son pair of lamps that starred in the short animated film, *Luxo Jr.* This two-minute movie debuted at the computer graphics conference Special Interest Group on Computer Graphics and Interactive Techniques (SIGGRAPH) in 1986. One

Pixar debuted their short film *Luxo Jr.* at the SIGGRAPH conference, where new developments in graphics are featured annually.

year later, it became the first computer-animated film to be nominated for an Academy Award. The nomination was the first of many honors bestowed on Pixar in the years that followed.

This short film catapulted Pixar—with Catmull and Lasseter guiding its technical and artistic vision—to the head of the new field of computer animation. Catmull, cofounder of Pixar and president of Pixar Animation Studios, says of the movie, "*Luxo* is the one that changed everything, that was a pure little story. And once we hit it with that, then [computer animation] became the new goal for everybody."[3]

A NEW LOOK

In *Luxo Jr.*, the father and son lamps participate in a simple story line. They are shown rolling a ball back and forth across a table. But they also express emotion and have a realistic, three-dimensional look.

At the time *Luxo Jr.* was made, most animation was hand drawn. Animators painstakingly drew and painted each frame of film. Disney's iconic characters and Warner Brothers' playful stories were made this way. They had inspired generations of children, many of whom grew up to become animators.

The look of characters in traditionally animated cartoons is lively and energetic, but the perspective is flat, like paper. Computer animation gave characters a three-dimensional look. It brought the characters to life in a new and exciting way.

Computer graphics are digital images, and digital animation is

COMPUTER PIONEERS COMMUNITY

SIGGRAPH was a vital meeting place for the computer graphics community in the early years and remains integral today. SIGGRAPH held its first conference in 1974. Since then, it has continued organizing annual conferences for members of the computer graphics community. Scientists, artists, and others in the field share their latest advancements and ideas. Tens of thousands of people attend the conferences, which have been held in Los Angeles, California; Dallas, Texas; Boston, Massachusetts; New Orleans, Louisiana; and other major US cities.

animations of those images. Both the animator and the medium are responsible for the unique look of computer animation. Animating on screen—rather than with pencils and ink on paper—gives the imagery and movement a different style. In computer animation, the colors may be more dynamic. Also, the computer allows animators to program realistic movements of fire, smoke, animal fur, and other things that would be too difficult or time-consuming for traditional animation. The programming allows animators to use physics in order to show gravity, acceleration, and deceleration of various objects in the animation as well.

TECHNICAL INNOVATIONS

But the Pixar team had to overcome many obstacles to create the short film. Lasseter collaborated with computer scientists for many months. The team had already figured out how to animate characters composed of simple geometric shapes. But this film presented some technical challenges. For example, animators had to show the ball rolling back and forth on screen in a realistic way. Eben Ostby, an early pioneer at Pixar, made advancements in something called procedural animation, a kind of animation

that is generated by a mathematical algorithm or equation.

Before Ostby introduced this invention, Lasseter recalls, "sitting there in front of these very expensive computers, with a hand calculator using my simple art-school math, trying to figure out, 'If a ball is this size and it's moving this fast, how far would it move?' What's wrong with this picture?"[4] With Ostby's advancements, Lasseter gained control over the movement of the ball. The algorithm would calculate the speed and motion of the ball.

A second technical innovation in *Luxo Jr.* was due to the fact that the lamp characters had the ability to light themselves. The team had to program this

CORPORATE CONUNDRUM

The lamp in *Luxo Jr.* was based on the lamp sitting on animator John Lasseter's desk. Since that time, Lasseter has excelled at animating inanimate objects, including the characters in *Cars*, the Pixar movie he directed in 2006.

But when he was originally modeling and animating the lamp, it was just as an experiment. That experiment led to the short film *Luxo Jr.* But no one who worked on the film, including Lasseter, imagined the impact the short film would soon have. So it never occurred to them to ask the company that made the actual desk lamp if they could use the image.

After *Luxo Jr.* was released and widely celebrated, representatives from Pixar realized there could be an issue with having used the lamp. The Luxo lamp was trademarked and Pixar had used it without prior permission. To resolve any potential problems, they contacted Luxo, the company that made the lamp. Pixar and Luxo came to an agreement. The lamp company was allowed to screen the film at trade shows and Pixar could continue to distribute the film.

beam of light, which moved as the lamps moved. They also had to program the shadows this light created. Lasseter and his team wanted the shadows to fall in a way that made sense. In order to achieve this, Bill Reeves, one of Pixar's earliest technicians, along with graphics technicians David Selesin and Rob Cook, developed an algorithm that would allow the shapes in the film to cast their own shadows. Their strategy was to make an algorithm that would generate an image, the shadow, from the perspective of the light source. The computer stored information about the distances between objects and those objects' distances from the light source. This information was used to calculate how each object's shadow would look. These innovations made the shadows in *Luxo Jr.* look realistic.

SOUND AND IMAGE

Luxo Jr. was the first of many collaborations between Pixar animators and sound designer Gary Rydstrom. For *Luxo Jr.*, Rydstrom felt it was important that the sound be playful, but also rooted in reality. To achieve the right tone, he recorded the sounds of lightbulbs turning in sockets, which made a metal-scraping-metal sound. Rydstrom went on to create sound design for many Pixar films including *Toy Story*, *A Bug's Life*, *Toy Story 2*, *Monsters, Inc.*, and *Finding Nemo*. In addition, he directed Pixar's short film *Lifted*, for which he earned his fourteenth Academy Award nomination.

THE DEBUT OF *LUXO JR.*

After months of work, *Luxo Jr.* was finally debuted at SIGGRAPH in 1986. It received prolonged and enthusiastic applause. The audience was surprised and delighted by the technological and artistic prowess of the short film.

The animators had overcome many technical obstacles to create the stunning new look of the computer-animated film. This alone was enough to impress audiences. But Lasseter, Catmull, and others at Pixar were also dedicated to the sense of story and character that makes animation special. While developing a new way to animate, they had retained the art form's ability to tell a story and to bring a character to life.

Bob Pauley, a production designer on two later Pixar films, *Cars* and *Monsters, Inc.*, remembers, "When I saw *Luxo Jr.* . . . you could tell that [the filmmakers] cared about character animation. It's beautiful—there's a story, there's heart; and I thought, 'I just want to work there.'"[5]

"It was the combination of the new medium and John [Lasseter] really bringing a character to life that made people say, 'Oh my God' and the smart ones say, 'Look at this potential.'"[6]

—Steve Jobs, founder, Apple Computers and CEO, Pixar Animation, from 1986 to 2006

A FIRST OF MANY FIRSTS

Luxo Jr. garnered the first Academy Award nomination for a computer-animated film in 1986. It was also John Lasseter's professional directorial debut. Lasseter went on to win two Academy Awards, including one for Best Animated Short Film for *Tin Toy*, the first computer-animated film to win in that category. He also continued to guide Pixar's creative vision.

In addition to its many awards and advancements, this short movie spawned the development of an industry. *Luxo Jr.* was the first success for what would become a very successful computer-animation company—Pixar. In honor of this film, a springy Luxo lamp still hops into the frame and stands in for the *i* of the Pixar logo at the start of every Pixar film. Each of the company's computer-animated movies is filled with a new cast of characters, who are created each time using innovations in computer-animation technology. +

A GOLDEN PRIZE

In 1987, *Luxo Jr.* received a Golden Gate Award. These awards are given out at the San Francisco International Film Festival, the oldest continuing film festival in the United States. *Luxo Jr.* won first prize for Computer Generated Imagery. The Pixar animators were very excited to receive recognition for their film.

Steve Jobs sits beneath a large Luxo lamp,
which has become the symbol of Pixar Animation Studios.

CHAPTER 2

Ed Catmull dreamed of using computers to animate movies.

MEET THE FOUNDERS

Ed Catmull attended Granite High School in Salt Lake City, Utah. Although he dreamed of becoming a professional animator, the gifted student did not see himself as a skilled artist, and he pursued math and science coursework instead. He

was a member of the debate team and was active in the math, science, and drama clubs at school.

Catmull entered the University of Utah in 1963. He was a student at the university just as its computer science program was gaining speed. Catmull applied himself with diligence and enthusiasm, often going above and beyond assignments to learn more. He graduated in 1969 with undergraduate degrees in computer science and physics.

After college, Catmull worked for the Boeing Company, an airplane manufacturing company, for a short time. But he soon returned to the University of Utah as a doctoral student in computer science in 1970. It was then that Catmull thought to fuse his childhood dream of being an animator with his interest in computer science. Catmull hatched a dream that would take two decades to come true: to make a feature-length film using computer animation.

The University of Utah Computer Science Department was an exciting place to work. Its reputation attracted people interested in computer science from around the world. Its graduates include some of the finest minds in the field of computer graphics. The environment was one of

experimentation and camaraderie, where doctoral students were treated as peers rather than underlings. It was an atmosphere Catmull would re-create at Pixar.

But even in this environment of experimentation, computer animation was novel. Fred Parke, a fellow doctoral student, explains, "Computer animation was sort of on the lunatic fringe at that time. People were just barely to the point where they could get a computer to put out still images."[1] Yet Catmull persisted.

ART AND TECHNOLOGY

Ed Catmull had always been interested in creating something artful, but his talent was mainly in science. Computer graphics allowed him to combine his interest in art with his talent for working with computers. "When I took that first computer graphics course, then bam, it hit me . . . here's the art and here's the technology, and I reoriented everything around that, and the goal was to make the first [computer] animated feature."[2]

While studying for his doctorate, Catmull experimented with computer graphics. In one project, Catmull created an animation of his hand. He made a plaster model of his hand and plotted a number of points on the model. He then carefully measured the numerous points and typed their coordinates into the computer. Using an animation program he had written, Catmull reproduced a three-dimensional, or 3-D, image of the hand on-screen.

This hand later became the first computer animation to appear in a feature film, when it was used in the 1976 movie *Futureworld.*

A PLACE TO EXPERIMENT

Catmull's excitement for 3-D animation was clear. One of his professors at the University of Utah was Ivan Sutherland, the inventor of the first computer-drawing device, called Sketchpad. Knowing Catmull's interest in digital animation, Sutherland traveled with him to Disney Studios in Anaheim, California. They tried to convince the legendary animation company of the possibilities of computer animation in hopes of landing Catmull his dream job. Disney executives did offer Catmull a position, but not in animation. They wanted him to use computers to design a theme-park ride. Catmull was not interested in designing rides, so he turned down the job.

His goal of making a computer-animated movie seemed a long way off. Catmull would need expensive equipment that was not readily available in most universities, let alone to the public. By this time, Catmull was married and had a young son. Unable to find a job developing tools for computer graphics and animation, he took a job as a

A SUCCESSFUL ACADEMIC PLAYGROUND

The Computer Science Department at the University of Utah attracted talent from around the world during the 1960s and 1970s. In 1965, the university hired Dave Evans, a professor at the University of California at Berkeley to run the Computer Science Department. Evans recruited talented faculty from across the country. Soon, the program grew into a thriving center for innovation in computer science, including a branch in computer graphics and animation.

One of the professors Evans recruited, Ivan Sutherland, had developed a system for drawing on the computer. Sutherland's system, Sketchpad, used a light pen on a computer display. A light pen allows users to draw directly on special computer monitors that work with the pen.

Henri Gouraud developed Gouraud shading, which imitates the effect of light on a solid object, known as shading in 3-D graphics. Bui Tuong Phong, created Phong lighting, a system to illuminate digital objects. Alan Kay developed the graphical user interface (GUI) for computer use. GUI allows users to point-and-click on objects on screen. Utah graduate Jim Clark is the founder of Silicon Graphics and cofounder of Netscape, and Nolan Bushnell is the founder of Atari video games.

programmer. But this would not last long.

A multimillionaire with a strong interest in technology, Alexander Schure was setting up a new school—the New York Institute of Technology (NYIT). While purchasing equipment from the University of Utah Computer Science Department, Schure learned about the talented graduate, Ed Catmull. Schure soon located Catmull and hired him to run the computer-graphics department at NYIT.

Catmull was charged with creating and running a computer-graphics department that could

eventually create an animated film. He had finally landed a job that gave him the equipment and the time to pursue his dream.

A CALIFORNIA HIPPIE

While Catmull was pursuing computer science at the University of Utah, an aspiring artist and skilled scientist on the West Coast was learning about the possibilities of computer painting programs. Alvy Ray Smith, cofounder of Pixar, received a doctorate in electrical engineering from Stanford University in 1968. He specialized in a branch of computer science called cellular automata. Working with a grid of cells, a computer engineer can program the individual cells to turn on and off in complex patterns. The effect is that the cells appear to move, creating an animation. After graduation, Smith taught courses in this field at New York University.

Smith eventually moved back to California, where he visited an old friend, Dick Shoup, who was working at Xerox's Palo Alto Research Center (PARC), a hotbed of innovation in computer graphics. Smith was initially skeptical that a computer would be able to adequately mimic painting. But he changed his mind completely when

Shoup showed him SuperPaint. The program offered a new way to paint with color using the computer. It was the first computer program to offer such options as virtual pens and paintbrushes, preset color palettes, auto filling of images, and the ability to alter colors by changing the hue, saturation, and value of the color. It was also the first computer graphics program to use a graphical user interface (GUI). GUI allows computer users to interact with objects on a computer screen. Prior to GUI, instructions had to be typed into the computer.

Smith was amazed at the capacity of the program. He took a job at Xerox PARC so he could experiment with SuperPaint. But when Xerox gave up its color imaging research, Smith's job ended. He and another artist from Xerox, David DiFrancesco, went to the University of Utah looking for equipment they could use to continue their research in computerized painting. The Utah faculty instead sent them to New York, where Catmull welcomed them to the team at NYIT.

FROM NEW YORK TO CALIFORNIA

The campus of NYIT, on Long Island's North Shore, was unique. Rather than traditional school

buildings, it consisted of former mansions on large estates. Catmull ran the Computer Graphics lab out of an expansive garage with an office, formerly the chauffeur's quarters, above it. Alexander Schure gave the small team everything they needed to invent the tools to create computer animation for film. As David A. Price writes in *The Pixar Touch*, "Schure was a true visionary of computer animation, staking a fortune on the idea at a time when the concept was difficult for others even to fathom."[3] NYIT provided important funds, as well as passion and enthusiasm.

In 1979, Catmull left NYIT to run the new Computer Division at Lucasfilm Group, founded by filmmaker, George Lucas. The studio's mega-hit, *Star Wars*, was released in 1977 and the successful film attracted many talented animators and computer scientists to the Lucasfilm Computer Division. In the years to come, Smith, DiFrancesco, and others from NYIT followed, forging a new hotbed of innovation in computer graphics in California.

LUCASFILM AND VISUAL EFFECTS

The Lucasfilm Computer Division worked with Lucasfilm's visual effects company, Industrial Light & Magic, to create a digital animation for *The Young Sherlock Holmes* in 1985. The animation featured a stained glass man. *The Young Sherlock Holmes* was the first film to composite computer-generated animation with a live-action background.

George Lucas wanted to use computers in the process of filmmaking, but he was not interested in making computer-animated films. At that time, cinema was still edited by hand. Editors had to cut sections of film and splice them together. Lucas was sure another way could be developed using the computer. He charged Catmull with the task of developing the technologies to composite film using the computer. This means taking two separate elements and layering them into one shot. Today, this is often done using a green screen. An actor is filmed performing in front of a green screen. Then, the film of the actor is layered over another scene, for example an explosion or an outer space scene. The actor was never in any danger, but the effect makes it look like he or she was really there. Lucas also asked Catmull to develop software for digital audio mixing, digital audio editing, and digital film editing.

With only two computers and no graphics software, Catmull, Smith, and a team of scientists set out to invent exciting new programs and technologies that would improve filmmaking. +

A technician at the University of Utah computer center produced a three-dimensional image in 1967.

CHAPTER
3

John Lasseter, *left*, and Ed Catmull teamed up to create computer-animated movies.

ART MEETS SCIENCE

One day, in 1982, Catmull received a call from a young Disney animator interested in using digital backdrops with hand-drawn animation in a short film, *The Brave Little Toaster*. Catmull and Smith met with the animator, John Lasseter, at

Disney. Many animators at the time shunned the idea of computer animation because they did not believe it was as artful as traditional animation. They also believed that it required less skill from animators because the computer programs took care of much of the work. But Catmull and Smith were impressed with Lasseter's enthusiasm, energy, and interest in the potential of computer graphics.

The Brave Little Toaster would be Lasseter's last project for Disney at that time. He was laid off the day the film was screened for executives. Lasseter and Catmull would not meet again until 1983, when they crossed paths at a SIGGRAPH conference.

When Catmull later called Smith from the conference to discuss business, he mentioned seeing Lasseter there. Smith, learning that Lasseter was no longer at Disney, urged Catmull to, "put down the phone and hire Lasseter *right now*."[1] Catmull followed his advice. Lasseter took the job at Lucasfilm, and he and Catmull have been close partners ever since. But Catmull's job did not include hiring animators. In order to get him a job, Lasseter was given the title of Interface Designer. Once on board at Lucasfilm, he began his first task, to create a digital character using the tools the team had been developing.

A DISNEY SCHOOL

California Institute of the Arts (CalArts) opened in 1971. It was the brainchild of Roy Disney, who had been planning the school since the 1950s, although it was not completed before his death in 1966. CalArts was the home of the famed character-animation program as well as programs in art, theater, and dance. The campus in Valencia, California, remains a thriving center for higher education in the arts.

Lasseter's training as an animator included years of drawing and watching cartoons. He had earned a bachelors degree in fine arts from the influential character animation program at California Institute of the Arts (CalArts) and then worked as a Disney animator. He had learned the essential and time-honored skills of animation, including how to imbue characters with emotion and motives and how to make their movements believable. But now Lasseter was faced with making a compelling character, not with the freedom of pencil on paper, but with the restriction of using the shapes that were then available to 3-D animation. These shapes were basic polygons, or 2-D shapes, that were created in the computer using mathematical equations.

CREATIVE COLLABORATION

The computer scientists at the Lucasfilm Computer Graphics Division worked hard to develop the

tools for digital filmmaking, including software for computer graphics, a digital editing system, and new sound technology. They also continued to make graphics using the new tools. When Lasseter was hired, they were in the process of making their first short film, initially titled *My Dinner with André*, after a 1981 movie of the same name. Catmull and the team hoped to impress Lucas and the studio with the capabilities of digital animation. With a trained animator on board, the Computer Division could not only create 3-D images, but they could also benefit from the knowledge of traditional animation. Lasseter understood how to use color and shape to make a pleasing image. He also understood how to use movement to develop a character. Lasseter used all these things to add to the storytelling of an animation. Lasseter was given the storyboards, a set of drawings that shows what will happen in the film, and he was asked to create the character of André, initially an android.

His first few days were challenging. "Everyone around me had PhDs," Lasseter recalled. "They were supersmart and inventing all this stuff. And I thought, 'Right. I don't even know how to type! I'm never going to do what they do.' And then I thought, frankly, 'They're never going to be able to do what

I do,' which is bring a character to life and give it emotion and personality through pure movement."[2]

Initially, Lasseter struggled to make a believable character out of the geometric shapes the computer could create. Looking to early drawings of Mickey Mouse for inspiration, he asked Catmull for another shape, a springy, teardrop shape. Catmull used the computer to create the needed shape. Using the new teardrop shape, Lasseter was able to create a character that was less like a robot and more like a boy. He also added a second character, a bee.

Throughout the process, Lasseter worked side-by-side with the computer scientists. Lasseter's requests pushed them to develop new tools, and their feedback helped him learn the digital animation process.

Catmull used the opportunity to make a program that would create a blur around moving objects. One of the scientists, Bill Reeves, wrote a computer program that would create flowering trees in an animated forest. Two others, Loren Carpenter and Rob Cook, worked to finish the division's rendering program, called Reyes. The rendering system would take all the elements of the animation—such as characters, background, light, motion, and shadow—and create a final image.

When the computer engineers and animators work on an animation, they use algorithms that contain all the information needed to make the image and the action on the screen. Rendering takes that information and "films" it to create the final movie.

ANDRÉ AND WALLY B.

As the film came together, its title changed to reflect the characters and story. The short film was titled *André and Wally B*. The story is short and simple, but it gave the team a chance to show what their new

A STAR ANIMATOR'S STORY

John Lasseter was born in 1957 in Hollywood, California. His parents soon moved to Whittier, where he was raised. As a child, Lasseter was transfixed by cartoons. He went straight home from school to watch them. A talented artist from a young age, he won his first art contest at age five.

It was not until he was a student at Whittier High School that it occurred to him that he could get a job drawing cartoons. He found a book about animation in the library. And from then on, he dreamed of becoming a Disney animator. Like other teens around the country who wanted to work for the famed animation studio, Lasseter sent letters and drawings to Disney Animation Studios, hoping to catch their attention.

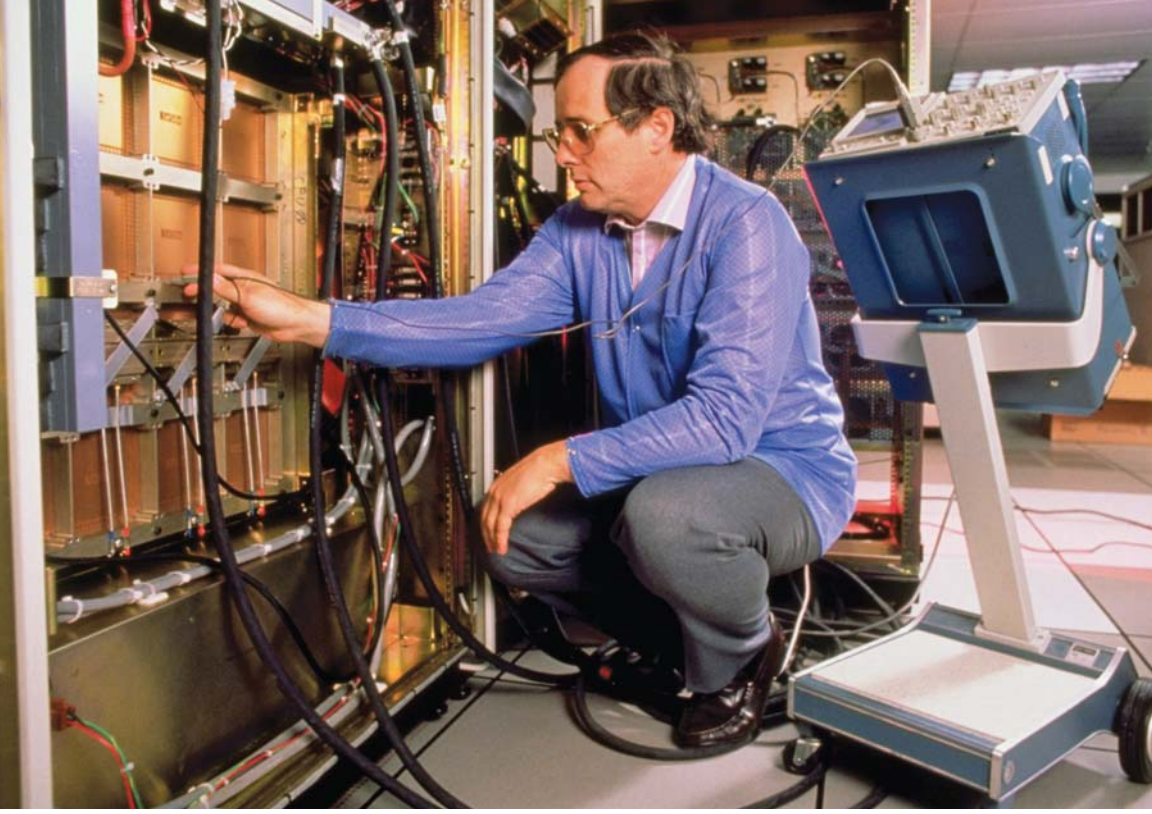
During his senior year, Lasseter received a letter inviting him to apply to Disney's new character animation program at California Institute of the Arts (CalArts). He put together his application and was accepted into the new department's first class.

Lasseter proved to be a talented animator. His work as an animator and director earned him numerous student awards. In 1979 and 1980, while studying character animation at CalArts, this budding talent won back-to-back Student Oscars for his short films *Lady and the Lamp* and *Nitemare*.

tools could do. The main character, André, wakes up in a beautiful forest only to find a pesky bee hovering nearby. André attempts to trick the bee and escape, but he ends up getting stung. Though less than two minutes long, it was a revolutionary short film. In addition to showcasing Lucasfilm Computer Division's new tools and technologies, it was the film to integrate the skills of a trained Disney animator. The team was excited to showcase the film at the next SIGGRAPH conference.

But before they could screen it, the film had to be rendered. Before rendering, animators and technicians work to program the movie. The film must be rendered for viewers to watch it. For just this short film, rendering would take a substantial amount of time and computer power.

Lucasfilm Computer Division had five VAX computers. These were among the most powerful computers of the time, but even using three of them 24 hours a day, there was not enough computer power to render the film in time for the conference. The team even took the film to the Massachusetts Institute of Technology (MIT), where they used ten more VAX computers and to Cray Research in Mendota Heights, Minnesota, where they used a new supercomputer, Cray X-MP.



A technician works on a VAX 9000 mainframe computer in 1989. VAX computers helped render Lucasfilm's early computer animations.

Despite using more than a dozen powerful computers in three states, the team had to substitute earlier drawings for a few frames not yet rendered. In this way, *André and Wally B.* screened at the SIGGRAPH Conference in Minneapolis, Minnesota, in the summer of 1984. No one seemed bothered by the unfinished frames; the movie was a smash hit. The audience was amazed to see computer animation done with the style and finesse of traditional animation.

AN END AND A BEGINNING

Despite the success of *André and Wally B.,* Lucas was losing interest in the Computer Division. Catmull, Smith, and others on the team at the Lucasfilm Computer Division had met the goals of developing technologies for digital compositing, sound mixing, and sound editing. Lucas had the digital filmmaking tools he had requested.

While developing the digital filmmaking tools and computer graphics, the Lucasfilm Computer Division had also created a computer called the Pixar computer. Although the computer was selling, Lucasfilm was not a computer company. Lucas did not wish to invest time and funds into selling these computers. He felt the same way about computer animation. Shortly after the screening of *André and Wally B.*, Lucas began looking for a buyer for the Computer Division. +

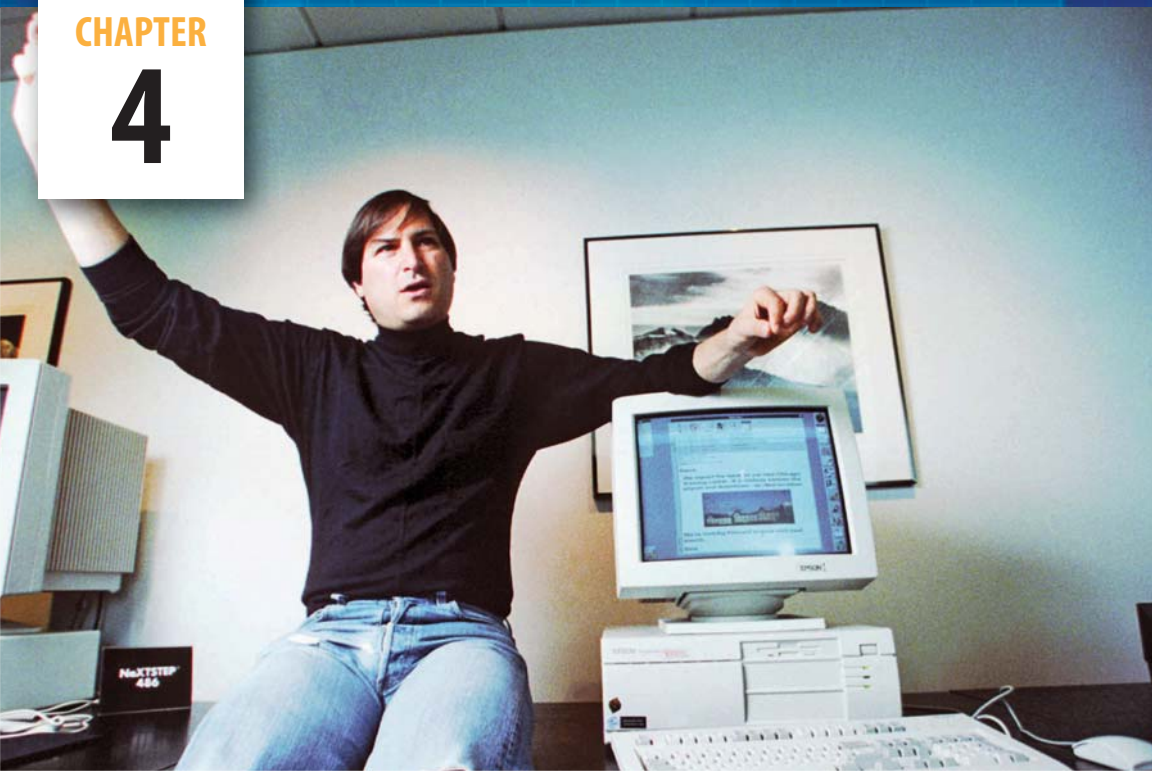
"The art challenges technology and the technology challenges the art."[3]

—John Lasseter

In 1984, George Lucas began looking
to sell the Lucasfilm Computer Division.

CHAPTER

4



Steve Jobs invested in Pixar in 1985.

A YOUNG COMPANY

With the Lucasfilm Computer Division up for sale, Catmull and Smith were determined to find a home, not only for the Pixar computer, but also for the group of talented technicians and scientists they had assembled to

develop computer animation and graphics. Lucas gave Catmull and Smith the task of finding a buyer, and they set about looking for someone who would acquire both the computer and the team.

Catmull and Smith held meetings with potential buyers in hopes of finding a way to continue their work. They approached Hallmark, Disney, and companies that worked in electronics and science. But none of these meetings resulted in a sale.

Catmull and Smith even met with the founder of Apple Computers, Steve Jobs. But Jobs wanted to run the company himself, and Catmull and Smith wanted to keep control. Jobs also insisted that the asking price of $10 million was too high; he suggested $5 million. Catmull and Smith left that meeting and continued to pursue other leads.

A NEW BEGINNING

By September 1985, prospects looked different to everyone. Jobs had resigned from his seat on Apple's board. He was interested in starting something new. Lucas was also eager to wrap things up with the Computer Division. So when Jobs offered $5 million as an investor only—without running the company—Lucas agreed to the price.

STEVE JOBS AND PIXAR

Steve Jobs founded Apple Computers when he was 21 years old, and he became a multimillionaire by age 30. Though Jobs initially wanted to run Pixar, he decided to invest after leaving Apple Computers in the mid-1980s. Jobs then started a new company, NeXT. NeXT was a computer hardware and software company. Jobs was heavily involved in running NeXT, and though he paid the bills for Pixar, he mostly left Catmull and Smith alone to run the company as they chose. However, Jobs has been an integral part of Pixar's success, negotiating its deals with Disney to produce animated films. Jobs eventually returned to Apple in 1996 when the company purchased NeXT for $429 million and he soon became its CEO. He remains a part of Pixar as well.

The papers were signed in early 1986, and the new company was named Pixar Inc. Pixar was cofounded by Catmull and Smith and financed by Jobs. Catmull became chief technical officer, and Lasseter became Pixar's first animator. Smith served on the Board of Directors and was executive vice president.

Before long, Catmull and Smith dropped the "Inc." from the name, and the company became Pixar. But the goal was not yet animation or even graphics—Pixar's first task was to get their computer, still just a prototype, ready to market and sell.

STRUGGLING TO STAY AFLOAT

As Catmull and Smith addressed new responsibilities, including hiring people to make, market, and manage the computer and software divisions, the small animation

department continued its experiments. Even though the company's priority was to develop the Pixar computer, Catmull and Smith continued to invest money in the animation department.

It was around this time that Lasseter began using the group's modeling software, Model Editor (ME), designed by Bill Reeves. The modeling software was used to create three-dimensional objects in the computer and also to animate them. Lasseter used the software to create a digital model of his desk lamp. The project evolved into *Luxo Jr.* The short film was a breakthrough hit for the new company when it screened at SIGGRAPH in 1986. At the same conference, Pixar also screened *Flags and Waves*, by Bill Reeves, and *Beach Chair*, by Eben Ostby. Both were well received for their technical and artistic achievements. But despite these successes, the company still needed to generate revenue.

By mid-1986, the Pixar Image Computer, as it came to be called, was ready for market. The computer would be able to create images, diagrams, and animations. Pixar hoped to sell the computer

COMPUTER COMPANY

In the late 1980s, Pixar was almost entirely a computer company. There were only about 10 animation employees out of the roughly 100 employees working at Pixar. The majority worked on developing, marketing, and selling hardware and software.

to industries that needed to create large images. For example, radiologists need to generate images of the human body when performing CAT scans and oil companies need to generate images of underground oil deposits.

The computer had high-quality and high-speed parts. It was perfect for computer graphics. The computer had a high price tag, $125,000 each. But Pixar's computer consisted only of the hardware, such as circuit boards and graphics cards. It lacked an interface, such as a monitor or a keyboard, and it lacked software. Buyers would either have to wait for independent software developers or hire their own to create the programs that would make the computer usable for their needs.

Pixar had been developing some software for the computer. But their software was developed for their own pet project of computer animation. Few companies besides Pixar were working in earnest on computer animation.

Not long after the Pixar Image Computer was released, the magazine *Computer Graphics World* reviewed the computer saying, "Who's going to buy a $125,000 image processor that requires a host computer and has software development tools but no software?"[1] After an initial burst of interest, sales

fell flat. The team of engineers at Pixar went back to work to develop the tools buyers would want with the next version of the Pixar Image Computer, but it remained difficult to sell.

ANIMATION TAKES A LEAP

As computer sales flattened, another team of Pixar engineers, led by Tom Hahn, completed a project they had been hired to do for Disney. They had been asked to develop a way to replace the paint-and-ink step of traditional animation, where artists lay down ink and paint the

RENDERMAN

In 1986, Pat Hanrahan, Pixar engineer and biophysicist, suggested marketing the 3-D rendering program, Reyes, used by the animation department. To do this, they would need to develop a new computer language for 3-D images. Along with Bill Reeves, Hanrahan began developing the new language. The result was Rendering Interface.

Before going to market, Jobs suggested changing the name to one Hanrahan had invented for another potential product, RenderMan. The ambitious new software went to market with the catchy name in 1989.

RenderMan describes 3-D scenes and turns them into the final digital images that viewers see in a Pixar movie. RenderMan takes the information about an animation—algorithms for color, pattern, light, motion, shadow, and other effects—and "films" the movie.

Despite the technical achievements of RenderMan, it did not initially find a large market. Initial sales were disappointing. Pixar engineers have also developed versions of RenderMan for use with many different programs and computers. Pixar continues to sell RenderMan to consumers and companies. Today, it is the industry standard for rendering. RenderMan has won numerous awards for its contribution to computer graphics and computer animation.

drawings by hand, with a computer process. To accomplish this, the team developed the Computer Animation Production System (CAPS).

CAPS allowed scanned pencil drawings to be digitally colored and composited. Upon its completion, Disney used CAPS for one scene in their 1989 movie, *The Little Mermaid.* Pleased with the results, the company decided to use CAPS for all of Disney's animated movies. CAPS was completed shortly after the Pixar Image Computer hit the market. As a result, Disney became the prime market for the computer.

A new version of the Pixar Image Computer was released in 1988 and sold for $295,000. But, as David A. Price explains in *The Pixar Touch*, "Sales continued to crawl. The company had created an incredible piece of technology, but the world, it seemed, simply wasn't interested."[2] +

LONG HOURS

Computer graphics was so new, exciting, and time-consuming in Pixar's early days that animator Lasseter often worked all night. He would take a catnap under his desk and wake up to begin work again in the morning.

Pixar got its first big break when Disney used its Computer Animation Production System to assist on animation for *The Little Mermaid*.

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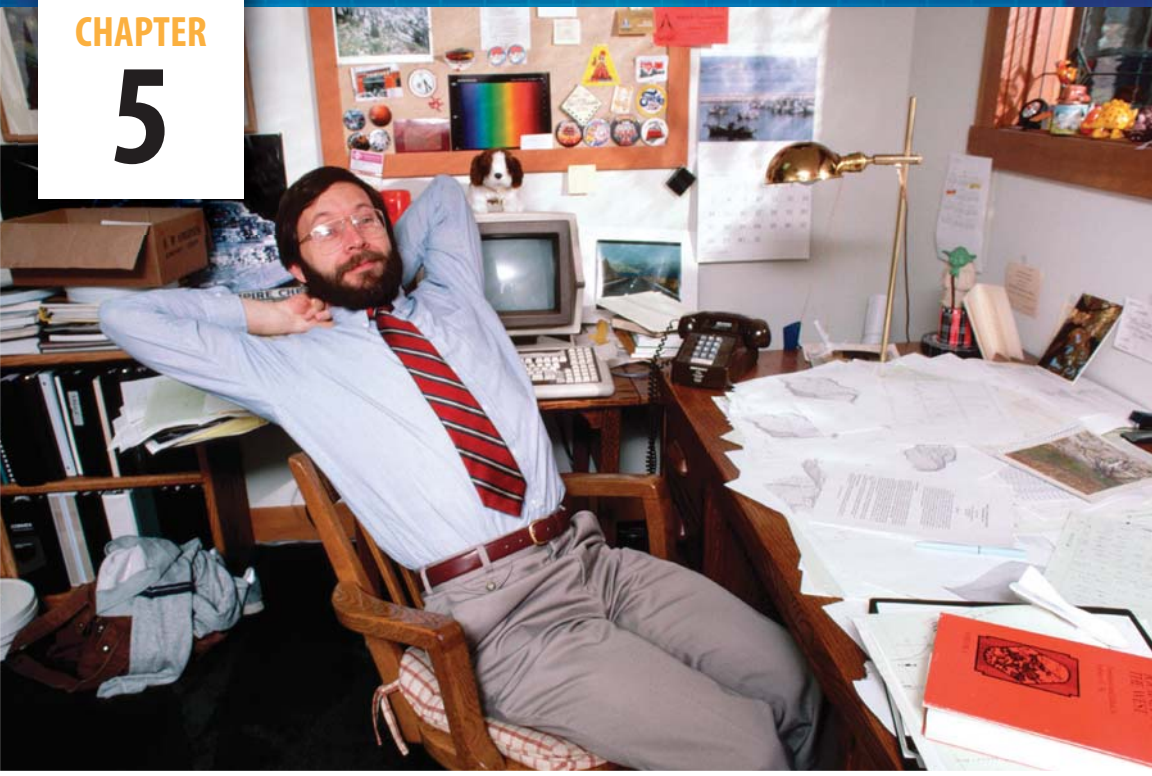

Ed Catmull had Pixar animators work on short films, which helped improve both the animators' skills and the software used.

SHORT STORIES

As Pixar marketed its computers and software, the animation department continued to innovate new tools for computer animation. The animation team did not yet have the tools or the finances to make a feature film, but making

short films gave them a chance to try out ideas and develop new technology. Each short film presented new challenges. Throughout, they strove to tell stories with compelling characters, fusing traditional animation skills with the new technologies they were creating.

Even after Pixar grew and established itself as an animation company making feature films, they continued to make short films. Shorts, as they are also called, give technicians ideas to improve the tools, and they allow animators to challenge themselves with new types of characters. Shorts also allow Pixar employees to try out new roles on a film. For example, a longtime animator may want to be the director on a short film. Pixar considers each short film as carefully as their feature films, instilling the characters with feeling and offering opportunities for laughter and emotion.

COLLABORATIVE FILMMAKING

After *Luxo Jr.*, Lasseter suggested that the team work on one short film using all their various software projects. Reeves used his software to create fluid images, such as smoke or rain. Ostby, inspired by his love of biking, was creating a model of a

bicycle. Lasseter wanted to work with a more human character.

To bring these ideas together into one film, Lasseter dreamed up a story that took place at night in a bicycle shop. The result was a short film called *Red's Dream*, a strange and sad story about a unicycle that dreams of being a circus star. The unicycle is ridden by a clown, and the unicycle steals the show.

It was a challenge for digital animators to make the nighttime scenes depicted in *Red's Dream.* Making the clown, an organic, living character, as opposed to a desk lamp, was a challenge as well. Also, creating the rows of bicycles in the shop required massive amounts of data.

When Lasseter showed *Red's Dream* at a SIGGRAPH conference in 1987, he earned something long awaited—the approval of his Disney mentors. Two of the speakers that day were Frank Thomas and Ollie Johnston, seasoned Disney animators. At the close of the film, they approached Lasseter with excitement, telling him, "You got it!"[1]

A MEETING OF MINDS

In the fall of 1986, a group of Pixar animators and computer engineers went on a retreat to

brainstorm ideas. One of the main problems they had encountered on *Red's Dream* was that they had outgrown their animation program, Motion Doctor. In particular, animating the clown had been a challenge. As writer Amid Amidi explains, "[Lasseter] compared it to writing on a word processor in which each letter typed on the keyboard would take five minutes to appear on the screen."[2]

At the retreat, the Pixar team came up with some good ideas to solve their modeling and animation software dilemma. The ideas led to a new piece of software they called Menv. This new software took into account each step of an animator's process. Using the Menv program, an animator could create a series of poses with a character.

A DREAM TO BELIEVE IN

A bicycle is a complex object with many different moving parts. A typical frame in the bicycle shop sequence of *Red's Dream* had more than 10,000 cones, cubes, spheres, cylinders, and other shapes. In computer animation, these three-dimensional shapes are known as geometric primitives. Each geometric primitive was made up of approximately 30 million polygons, shapes with four or more sides and four or more angles. Geometric primitives are then combined to form the bicycles and other objects in the scene.

The story was a change for Pixar, too, in that it lacks a happy, Hollywood ending. In *Red's Dream*, the unicycle upstages the clown in the dream. After the applause dies down, the unicycle wakes up alone again in the bike shop. The ending of the short film shows the unicycle slumped sadly in a corner. Many people encouraged Lasseter to change the ending and make it more upbeat. But Lasseter stayed true to the story.

But, unlike traditional animation, the animator would not have to create each and every frame. Instead, the animator could create a few key frames, and Menv would fill in the missing frames.

Reflecting on the retreat, Reeves recalled, "Without those ideas and the software that grew from them, Pixar's feature films would not have been possible."[3]

NEW CHALLENGES

Menv was developed at about the same time as the company's rendering language and software, RenderMan. With all this new technology to use, Lasseter challenged the group to animate a human character. This idea grew into the next short film, *Tin Toy*, about a baby and a toy from the point of view of the toy.

Making a human baby with the available technology was a real challenge. Lasseter and Reeves, respectively director and technical lead on the film, bought a baby doll for reference. They drew a grid on the doll's face and digitized it. Then Reeves wrote a program that allowed them to control the face. Believable facial movements are important to creating a realistic human character.

Tin Toy was a great success. At the time, it was one of the first examples of a human character made with computer animation. Though it was a huge achievement at the time, by today's standards, the baby in the film looks rough. In 1989, *Tin Toy* garnered director and animator Lasseter the Academy Award for Best Animated Short Film.

Despite the technical and artistic achievements of the short films, the animation group still did not bring in revenue for the company. Steve Jobs had taken a loss every year since investing. The animation department would have to start pulling its weight financially.

PIXAR COMMERCIALS

The company's short films had garnered attention from corporations. And several companies approached Pixar to make commercials. The animation department was initially against

COMMITMENT TO PIXAR

Lasseter's many short films and his Academy Award gained the attention of other movie studios. Disney, the animation studio he had been laid off from years before, asked him to come to work there as a director. But Lasseter was committed to Pixar. As Catmull says in the movie, *The Pixar Story*, "John is being asked to come down and be a director at Disney *or* he can stay up in Northern California with this company that is bordering on collapse because they're losing money. [smiles] He stays up here with us, a company on borderline collapse."[4]

the idea of making commercials. They preferred storytelling and working with their own creative ideas. But with sales of computers and software down, they decided to take on some commercial projects.

The Pixar animation department made their first commercial, for Tropicana orange juice, in 1989. The following year, the group made commercials for a variety of companies including Lifesaver, Listerine, Pillsbury, Trident Gum, and Volkswagen. The influx of work allowed the department to work out new ideas, learn to manage time and workflow on projects, and gave them the chance to hire two new animators, Andrew Stanton and Pete Docter.

The commercials brought Pixar creative, and financial success. But they only earned the company $1.3 million in 1990. Pixar was still in deep debt. By the end of 1990, the company had a net loss of $8.3 million, and Jobs was growing impatient. +

Despite having animators create commercials for a number of companies, Pixar was still losing money under Catmull's direction.

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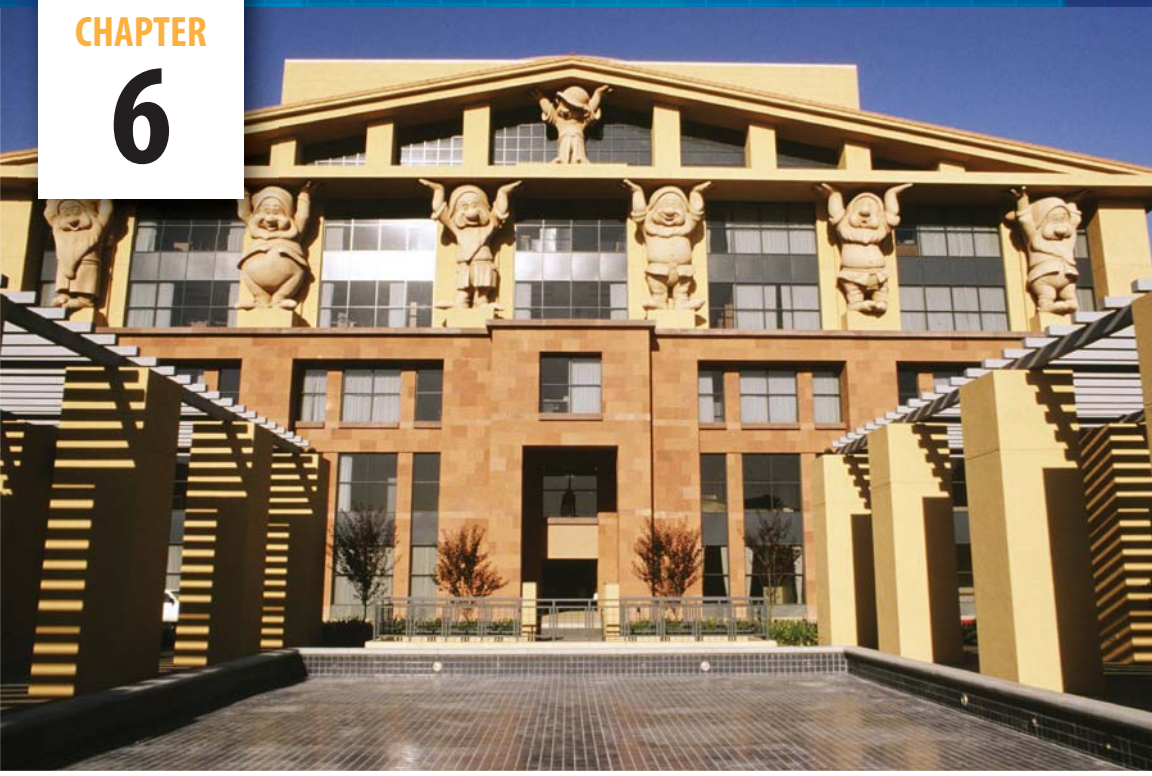

Pixar employees flew to Burbank, California,
to meet with Disney executives at their headquarters.

THE ROAD TO SUCCESS

In the spring of 1991, Catmull and Smith learned that Disney might be interested in making a film with Pixar. The Pixar group met with Jeffrey Katzenberg, an executive at Disney in charge of animation. Lasseter, Catmull, Smith, Jobs, Reeves,

and Ralph Guggenheim, who worked with the animation department, headed off to Disney.

Uncertain whether the animation giant would be willing to make a feature film with the new technology, the Pixar team brought an idea for a 30-minute television show. Even this would have been far longer than anything the Pixar animation group had made yet. The group pitched its idea, showing some shots they had put together and describing the story. Katzenberg liked the idea, but he was not interested in spending time and money on a television show. He wanted them to make a movie. After waiting more than a decade, it looked as if Catmull's dream of making a computer-animated feature—a dream the Pixar animation group passionately shared—was about to come true.

THE DEAL

During negotiations with Disney, Smith announced he was leaving Pixar to start his own company. Smith, who did not have a good working relationship with Jobs, felt that he could no longer continue working at Pixar. Smith continued to work in computer graphics, and he founded Altamira Software, which developed drawing and image editing software, in 1991.

Meanwhile, negotiations got underway and the deal was approved. Disney and Pixar signed a contract for three films. However, the contract allowed Disney to decide whether or not to do the second and third films. Also, Disney would have the last word on any creative decisions and have ownership of the film and any sequels.

Although the deal was not ideal for the Pixar team, the animation group could hardly contain their excitement. "I remember [when] Bonnie Arnold, the producer, and Ralph Guggenheim, the producer, came around and they said, 'We're making a movie.' And we said, 'Really?' It happened, and it was like, we're actually going to make this movie. And I was *so* excited," Lasseter recalled.[1]

THE WORK BEGINS

Signing the deal was just the first of many steps. This would be the longest and biggest job Pixar animation had undertaken by far. They would now have to make nearly 90 minutes of computer animation compared to the three- to five-minute commercials they were used to.

On top of all that, the pressure was on to make a great film. Disney's animation group, likely

threatened by the new technology, was not entirely supportive of the idea to make a film using computer animation. The Pixar team knew it was going to have to prove itself with this project.

Lasseter worked with two other animators, Andrew Stanton and Pete Docter, to write a summary, called a treatment, that outlined the story of the film they called *Toy Story*. It included two main characters; both were toys that desperately wanted children to play with them. Next, they created the characters and animated them in a 30-second test.

The test showed off the benefits of computer animation. Guggenheim said of the test,

"A WHOLE NEW THING"

When Tom Hanks was asked to voice the character of Woody in *Toy Story*, he was shown a sample animation to give him an idea of what the movie would look like. Hanks recalled of the time,

> *They said, look we just want to show you this thing because it's too hard to explain what it is. When I saw this loop, it was startling and kind of hypnotic. I must have watched it three or four times. It didn't look like animation. It looked like plasticene [modeling clay] come to life! I couldn't explain, even to friends, what it was like. I just said, well it's going to be this whole new thing. They've just invented something which is a brand new way of doing [animation].* [2]

Hanks enthusiastically agreed to do the voice of Woody. Tim Allen costarred in the role of Buzz Lightyear. Other actors in *Toy Story* included Wallace Shawn, Don Rickles, and Annie Potts. As Hanks had thought, *Toy Story* did represent something new. It was the first of its kind: a computer-animated feature film.

> *John [Lasseter] very wisely wanted to feature in that film a number of things that could not be done in conventional hand-drawn animation. So it took place in a room that was sort of dimly lit with Venetian blind shadows falling across the room, with a character (Woody) who had a plaid shirt on, which you could never do in hand-drawn animation.*[3]

THE SCRIPT

Once the characters and the main idea were approved, it was up to Lasseter and the story team, which also included Stanton, Docter, and Joe Ranft, to develop the story. Ranft had some experience working on features at Disney, but other than that, the team had little to no experience writing movies. To learn how, they attended a screen writing seminar, watched movies with similar themes and characters as theirs, and collaborated with professional screenwriters.

Slowly, through this process, the main characters, Woody and Buzz Lightyear, gained personalities and goals. The team began writing dialogue, and the story began to come together. When the script was approved, it was time to find

actors to voice the characters. The team was pleased to get actors Tom Hanks and Tim Allen to voice the main characters of the film.

Hanks and Allen recorded the dialogue. With the sound recorded, the Pixar team was finally ready to make a rough draft of the film.

A BIG BUMP IN THE ROAD

Meeting Disney's expectations for the film proved to be difficult. Katzenberg wanted the movie to be edgy, snappy, and dark. The Pixar animation group adjusted the characters and the dialogue to meet Katzenberg's approval. They worked all year to create storyboards. Then they put these elements together into a rough draft of the movie.

In December 1993, Lasseter and his crew flew to Disney's studios in Burbank to screen the rough version of their movie. As it turned out, all their compromising with Disney executives had

"I think the hard part for me, and probably for a lot of others, was that it was really hard to know from those story sketches to the finished product what [*Toy Story*] was going to look like, which is really scary stuff. I remember even halfway through the movie and we were seeing most of the first half of the film fairly completed and in color, I was still thinking, I don't get how this is all going to work at the ending because there was this huge chase scene at the end. It was like they did it all in one day. And suddenly it was all in there and I remember saying to my wife, now I get it."[4]

—Roy Disney, cofounder, the Walt Disney Company

resulted in a film that just did not work. Everyone was disappointed. Roy Disney remembered seeing the film and said, "It went on and on and on and on, and I was fast forwarding through it thinking, oh no, it will never end."[5] Woody's character had so much edge that he had become mean and bitter. The executives at Disney rejected the film.

Disney shut down the production. But Lasseter and his team did not give up. Instead, they went back to the studio and started over. With energy and determination, they worked together to change the story and make new storyboards. Within a couple of weeks, they had brand new storyboards and a much better movie.

They brought the new storyboards to Disney, and it was enough to show that the movie had potential after all. Production restarted and *Toy Story* was on its way. +

**Although their first attempt at *Toy Story* failed,
John Lasseter was determined to make the film a success.**

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The animators and staff of Pixar Animation, with CEO Steve Jobs, relax after their work on *Toy Story*.

A COMPUTER-GENERATED FEATURE

Once production was underway on the new and improved version of *Toy Story*, the Pixar crew grew from 24 to 110 members. Among this group, 27 were animators, 22 were technical directors—technical directors worked with animators

on a range of jobs including writing programs to make the animation work—and the rest were artists and engineers.

Making any kind of movie requires many people to work together. Making an animated movie is a multistep, collaborative process.

BRINGING CHARACTERS TO LIFE

The animation department was responsible for bringing the 3-D models to life, giving them movement and emotion. With Lasseter overseeing the work, animators Rich Quade and Ash Brannon led the animation team.

At Disney, animators typically worked on the same character throughout the film. But for *Toy Story*, with a few exceptions, Lasseter decided that the animators would work on all the characters in whichever scenes they were assigned. This added to the collaborative process: all the animators helped design the characters' movements.

MOVING MODELS

Technical directors and longtime Pixar employees Reeves and Ostby were responsible for the models for the two main characters in Toy Story. Reeves modeled Woody and Ostby modeled Buzz Lightyear.

Just as in traditional animation, the animators created what are called key frames, pictures that show the characters' main actions through a sequence of movements—character's minor actions are omitted from the sequence. For example, if a character is shown standing up from a chair, an animator making key frames may only show the character in the chair and in standing position. The animators used their computers to pose models of the characters in key frames using the animation program Menv. Whereas in hand-drawn animation, a less experienced animator would draw the motions that fit in between those of the key frames, for *Toy Story*, the computer program created the pictures for the in-between motions. Animators are able to develop the characters through their movements. In

WALKING IN THE CHARACTERS' SHOES

In order to understand how to animate a group of green plastic army men that appear in *Toy Story*, Lasseter nailed a pair of tennis shoes to a board, stepped in, and tried to walk. This experience helped make sense of how to animate the set of army men in a believable way.

A still from the finished film *Toy Story* shows the characters Buzz Lightyear and Woody.

this way, they use computer programs and their animation skills to tell the story and bring characters to life.

FROM COMPUTER TO MOVIE SCREEN

Other departments brought color, light, and texture to the shots. The shader department, led by Thomas Porter, used Pixar's RenderMan software to bring color and texture to each shot. Shaders are programs that define different surfaces with patterns, colors,

and textures. For example, Woody's cowboy outfit required 15 different shaders.

Toy Story's lighting department, led by Galyn Susman and Sharon Calahan, set the mood of each shot. Their digital imagery and computer software gave them a wide variety of lighting options and a great amount of control over the lighting.

When completed, each of the 114,240 frames that make up the 1,561 shots in *Toy Story*'s 77 minutes of animation then had to be rendered. This process puts the work of all the various departments together. *Toy Story* was rendered on 117 computers that ran 24 hours a day. Depending on the complexity of each frame, rendering could take between 45 minutes to 20 hours. About three minutes of film emerged per week. Although rendering still took a very long time, scenes of *Toy Story* were rendered as animators and technicians completed them. Pixar would not be stuck waiting several months for the film to render.

When all this work was complete, the camera department was responsible for recording the digital frames that were rendered onto film so that could be shown in movie theaters. Music and sound would be added later.

LOOMING UNCERTAINTY

People were excited to work on *Toy Story* because it was new. But the very novelty that fueled animators' and engineers' enthusiasm had Pixar's owner, Steve Jobs, worried. Jobs had already invested close to $50 million in Pixar and had yet to get significant return on his investment. As Catmull, Lasseter, and others at Pixar gave *Toy Story* their all, Jobs quietly began to look for a buyer for the company.

But instead of selling the company right away, Jobs decided to license Pixar's patents on its software. Patents give inventors the exclusive right to

TOY STORY'S TOY STORY

Around the time of the movie's release, a representative from Disney's Consumer Products Division met with *Toy Story* coproducer Ralph Guggenheim and watched a clip of the film. Guggenheim was excited about the potential toys that could be made for their film, but the Disney representative surprised him by saying that the clip did not show much potential for marketable toys.

Disney Consumer Products passed on licensing the characters from *Toy Story*, so the Pixar team looked to other toy companies. But, time was running short and the toy makers would not have the 18-month window they preferred to make new products. As a result, two big toy companies, Mattel and Hasbro, also passed on the chance to make Woody and Buzz Lightyear dolls for kids.

At a toy fair in New York City, representatives from Toronto toy company Thinkway saw a clip of *Toy Story*. They decided to purchase the license to make dolls of Woody and Buzz Lightyear. Because no one else had opted to make the toys, the small company was able to purchase the worldwide license. They ended up making toys for the highest-grossing movie of the year.

use and sell their inventions. By licensing Pixar's patents, other companies could produce and sell Pixar's software—for a price.

Jobs also decided that he would wait until *Toy Story* was released to take the company public. When a business owner takes a company public, it means that he or she makes shares of the company available for sale on the stock market. In this way, anyone who buys a share of stock owns a piece of the company. But in the early 1990s, most serious investors did not put money into a company that had never made a profit. Jobs was advised against taking Pixar public, but he believed it would help the company. Whether the movie was a success or a failure, Pixar's fate would be decided when it was released on November 22, 1995.

LASSETER RECOGNIZED AT THE OSCARS

Lasseter received special recognition for his work on *Toy Story*. He was given a Special Achievement Award at the 1996 Academy Awards for his "inspired leadership of the Pixar *Toy Story* team resulting in the first feature length computer animated film."[1]

WILD SUCCESS

Toy Story was a fantastic success. The *New York Times* called it "the sweetest and savviest film of the year,"[2] and critics and audiences overwhelmingly agreed.

Toy Story was released on 2,400 movie screens across the country, and it quickly earned $10 million in ticket sales. Over the three-day Thanksgiving holiday weekend, it made another $28 million. *Toy Story*'s success continued and it went on to become the highest-grossing film of the year, making more money than any other movie.

Even Pixar's own employees were shocked by the response to the movie. Catmull was stunned to see a wide array of *Toy Story* images and toys stacked up at fast-food restaurants and toy stores. He, of course, knew the movie was being released. But to see Woody and Buzz on posters, cups, and plates in Burger King was a real surprise.

Jobs took Pixar public on November 28, 1995, six days after *Toy Story*'s release. Throughout the day, shares of Pixar stock sold rapidly with the price increasing by the hour. Individual shares began at $22 apiece and went up to as high as $49.50. In all, the sale gained Pixar $139.7 million. This was a huge accomplishment for such a small company.

RECOGNITION FOR *TOY STORY*

Toy Story was a great success at the box office, and critics loved the film as well. When it was released, *Toy Story* received two Golden Globe nominations and three Academy Award nominations. Pixar did not win either of these prestigious awards that year, but for many of its later films, Pixar would walk away with numerous awards for excellence.

In addition to the rewards of happy audiences and financial success, *Toy Story* represented the fruition of a long-held dream. Catmull recalled,

> *A lot of people said, congratulations, you guys did what you said you were going to do and you spent your whole careers doing it, so there was this great feeling of elation. And then when it was done, I was like, now what?*[3] +

Tim Allen, *left*, and Tom Hanks attended the premiere of *Toy Story* in 1995.

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In 1997, Disney's Michael Eisner, *right*, announced that Disney and Pixar would make five movies by 2007.

LIFE AT PIXAR

With the success of *Toy Story* and the lucrative stock sales, Pixar was on its way to becoming a very successful computer-animation company. But in order to keep going, some changes had to be made. The first thing Steve

Jobs did was to negotiate a new deal with Disney in 1997. On the first movie, Disney had given all of the financing and thus received the lion's share of the profits. But things were different after *Toy Story*. Pixar was now making a profit, and it could afford to help finance the film.

Jobs insisted that Pixar would pay its share of costs and also share equally in the credit and profits of future movies. The initial three-movie deal from 1991 was revised to include more films and to adjust the profits. Disney and Pixar would be partners, sharing everything fifty-fifty.

SHORT SUCCESS STORIES

Making short films has always been important in allowing Pixar to continue to experiment, technically and artistically. Shorts do not take as long or cost as much to make as feature films, so more animators have the chance to bring their ideas to fruition through short films. During the busy *Toy Story* production, Pixar took a break from making short films, but they started up again shortly afterward. In 1998, Pixar's *Geri's Game* won the Academy Award for Best Animated Short Film.

PIXAR LEADERSHIP

As president of Pixar, Catmull strove to create the kind of collaborative environment he had enjoyed at the University of Utah and had inspired him both at NYIT and Lucasfilm. This spirit of mutual respect and collaboration had helped Pixar through

challenging times. Now, it would fuel its growth, by fostering curiosity, learning, collaboration, and teamwork.

On many occasions, Catmull had fought to maintain the animation department. But after the success of *Toy Story*, Catmull no longer had to convince anyone that computer animation was viable. Instead, he had to work to keep up morale and maintain loyalty and commitment. On most Hollywood movies, a large number of employees are hired on a per-project basis and let go at the end of the movie. To avoid this, Catmull had the team start work on their next movie, *A Bug's Life*, almost one year before *Toy Story* was released. He also put artists and engineers to work on other projects, such as animating short television programs with Woody and Buzz Lightyear. He believed that job security would foster a more positive environment.

When the company went public, more people became involved in overseeing Pixar's work. Catmull's title changed to senior vice president and chief technical officer. He became one of a three-part leadership team that included Jobs as chairman and chief executive officer (CEO) and Lawrence Levy as chief financial officer (CFO). In explaining the new leadership arrangement to employees, Catmull

"joked that nobody wanted to be president and he hadn't been able to get anyone else to take the job."[1]

WORKING TOGETHER

Lasseter, the creative voice behind Pixar since its earliest days, shared Catmull's belief in teamwork and collaboration. As *A Bug's Life* got underway, Lasseter assigned Andrew Stanton, who had played an important part in developing the story, the role of codirector. Having a codirector would relieve some of Lasseter's work. But it also gave someone else a chance to step into the director's role.

BUG BODIES

As in *Toy Story*, groups of people in different departments worked together on *A Bug's Life*. But the second film presented a new host of technical and artistic challenges. It was a big story filled with multiple characters. This tested the story team's ability to develop the different story lines and keep the characters consistent.

To create realistic surfaces for the bugs in *A Bug's Life*, the technical department turned to an idea Catmull had developed in graduate school with fellow student, Jim Clark. The technique, called subdivision surfaces or subdivision meshes, made it easier to generate the soft, smooth surfaces that make the bugs look just right.

A Bug's Life also has large crowd scenes of bugs. These important scenes posed yet another challenge for the technical team. At the time, they only knew how to create scenes with up to 50 characters. Lasseter formed a department to work on the problem. The group that came to be known as the crowd team worked together to find a way to create hundreds of bugs together. These crowd scenes became a powerful part of the movie.

Coming off the smash success of *Toy Story*, Stanton said,

> *The biggest fear was—can you find that lightning in a bottle again? Can you make yourself as in love the second time around? And you realize you have to actually work now at making yourself as naïve as you were in the first round without any effort.*[2]

One of the first things Lasseter and Stanton did was to rig up what they called a bug-cam, a small camera mounted on a stick. They took it outside to look at plants from a bug's perspective. Lasseter said that, "One thing we noticed from the bug cam was how translucent everything looked. It was breathtaking."[3]

A Bug's Life opened during Thanksgiving weekend of 1998. The film was a great success. It broke all previous US box office records for that weekend, grossing almost $163 million in domestic sales that year.

STRETCHED TO THE LIMIT

Unlike many other movie studios, Pixar had decided early on not to purchase stories or ideas from others, but to develop them in-house. This process allowed

the studio to nurture talent and offer employees the opportunity to develop and create their own ideas on film. So while Lasseter and Stanton were working on *A Bug's Life*, another group at Pixar had started a sequel of *Toy Story*.

Lasseter and others at Pixar watched the rough version of the *Toy Story* sequel. With a lot of anxiety, they realized it needed to be remade. Lasseter stepped in as director with Ash Brannon and Lee Unkrich as codirectors. Just as they had done with the first *Toy Story*, they regrouped and started over, rewriting much of the script and making new storyboards. The process was long and taxing. Although the finished movie represented another smash hit for Pixar in 1999, it had exhausted the crew.

Catmull recalled that they learned an important lesson on that movie,

A FILM FROM THE COMPETITION

Just ahead of the release of *A Bug's Life*, Dreamworks SKG, a new studio cofounded by Jeffrey Katzenberg (formerly at Disney and involved in the *Toy Story* production) released their own computer-animated movie called *Antz*. Despite some concerns about competition from Dreamworks' similarly themed movie, *A Bug's Life* became the highest-grossing animated film of 1998.

> Toy Story 2 *was a pivotal moment in this company. . . . we learned that the important thing is not the idea; the important thing is the people. It's how they work together, who they are, that matters more than anything else.*[4]

A CREATIVE PLAYGROUND

Meanwhile, Pixar's staff continued to grow. Between 1997 and 2001, the employee roster grew from 375 to more than 600, and they were spread across two buildings.

Jobs said, "We want to put everyone under one roof, and we want to encourage unplanned collaborations."[5] In 2000, the company moved to a large, new office located on 20 acres (8 ha) in industrial Emeryville, California. The new space has areas where employees from different departments could run into each other and talk about their work. And, with the goal of making one movie per year, it also has space to allow multiple productions to run simultaneously. Lasseter said, "The building itself has helped so much because Pixar is its people. We maintained the same philosophy of an office as an empty canvas and it's so fun!"[6] +

Animator John Lasseter received an Oscar in 1996
for his work in animation.

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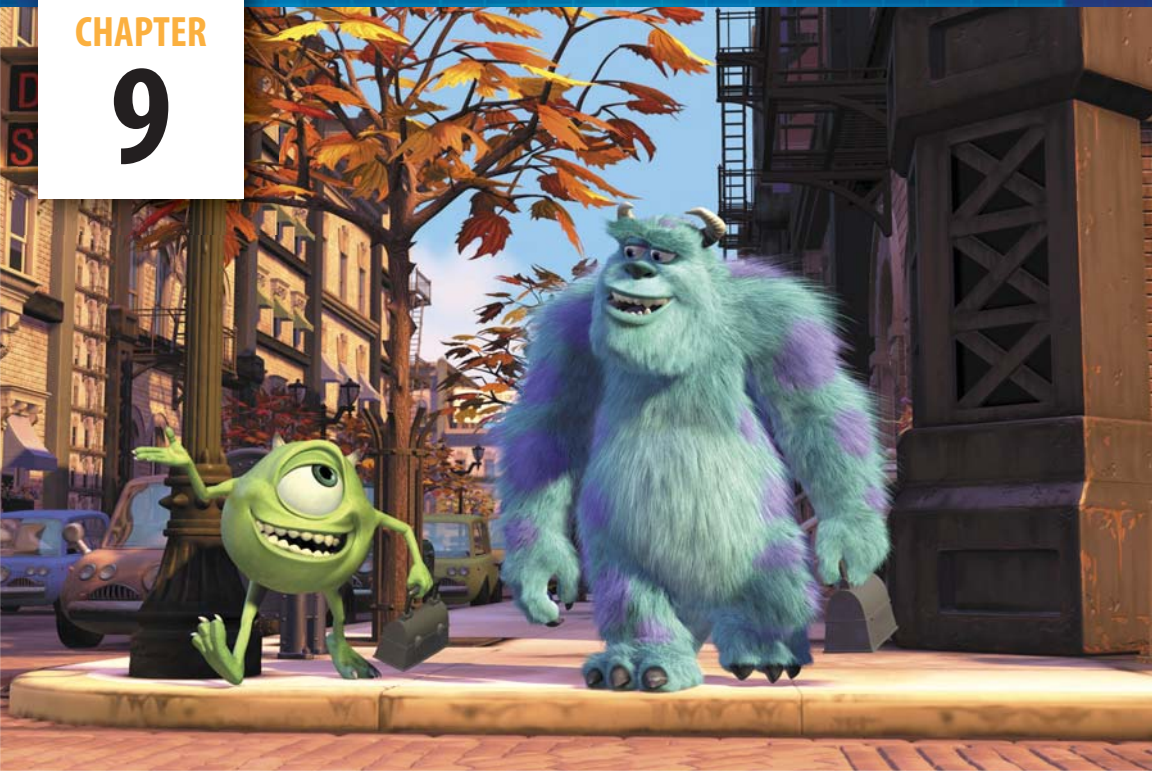

The film *Monsters, Inc.* posed new challenges for the Pixar animators.

MAKING A COMPUTER-ANIMATED FILM

Pixar had three wildly successful films under its belt. Lasseter had transitioned from being the only animator in the early days to leading teams of animators as director. He had shared the director's credit on *A Bug's Life* and *Toy Story 2.* But

now he thought others were ready to step into the director's role. He chose animator and longtime Pixar employee, Pete Docter, to direct the next movie.

Docter's initial idea for the film was that the monsters kids imagine in their closets at night are real. From this, the Pixar team developed *Monsters, Inc.* By this point, Pixar was working like a well-oiled machine. The team had worked out the kinks in its process. It knew the best way to take an idea from concept to finished film. To do this, a film goes through a series of stages. These are the same stages that every Pixar movie now goes through. Each one involves collaboration, teamwork, creativity, and critical thinking to solve technical and artistic problems.

"I think when [the process of making a movie] becomes collaborative is the point at which the film takes on a mind of its own, and you realize I'm not leading this, I'm following it. It's my job to shape it and move it along, but everybody's in service of the film, even the director."[1]

—*Pete Docter, Director,* Monsters, Inc. *and* Up

DEVELOPMENT

The first stage of making a Pixar film is development. This is when the story line gets developed. It begins with what is called a pitch. One of the Pixar employees pitches, or describes, his or her

idea. He or she has to sell the others on the concept with pictures, sound effects, and whatever is needed to get the team excited.

Once the story idea is accepted, development continues with brainstorming meetings. Employees toss around ideas and stay open to possibilities of how to make the idea into a great movie. Eventually, the story begins to unfold and the story team writes a treatment with the basic idea for the movie.

For *Monsters, Inc.*, Docter's initial concept—that monsters are real—could have developed in any number of ways. The story team played with ideas and came up with the story line. The story explains that the reason monsters scare children is because they need the energy of children's screams to power their city. The monsters would also be afraid of contamination by children. The main character is a monster named Sulley. As the story was further developed, the whole plot of the movie was outlined with a beginning, a middle, and an end. The script and storyboard fleshed out the initial ideas to create the movie.

The development phase also includes research. For *Monsters, Inc.*, Lasseter and Docter said they "went to the monster experts: Kids."[2] This assured them that monsters were scary, but they still were not

sure how their monsters should look. They visited the library to look for pictures of monsters, but ultimately decided to make up their own monsters. So for *Monsters, Inc.*, artists and illustrators made inspirational drawings to generate ideas for the monster characters.

PREPRODUCTION

During preproduction, the technical teams addressed any issues or concerns that the particular film brings up. For example, in *Monsters, Inc.*, many of the characters have fur. This presented a new challenge for digital animation, and the technical team wrote new software to generate the look and texture of different kinds of fur.

Once the story is laid out, the storyboard artists begin to make drawings of the action. Storyboards are like mini-cartoons. They are hand-drawn pictures that show the characters going through sequences

MONSTER FUR

The monster Sulley is covered in 2,310,413 computer-animated hairs. The technical team on *Monsters, Inc.* developed software to digitally manipulate each hair. This carried information such as the size, length, and color of every strand.

of action. Storyboard artists are each given pages of the script or notes on one character's sequence of emotions. They envision what the scene should look like and make drawings. They show these to the director for feedback.

Meanwhile, the story department continues to polish the script. Once the script is ready, the voices are recorded. For *Monsters, Inc.*, the crew had to hire many actors to voice the many different monsters. Actor John Goodman played Sulley and Billy Crystal played the other main character, a monster named Mike. The actors are recorded performing their lines while the Pixar staff fills in the other dialogue in what are called scratch voices. The recordings of these lines are meant to be temporary, but sometimes the scratch voices are really good, and they stay in the film.

The voices are then added to a sequence of storyboard drawings. This allows the director and others to get a sense of the timing of the shots and the flow of the story.

PRODUCTION

While the sound recording and script polishing continue, the art department creates the look of the

characters, sets, and props. They also make what are called "color scripts," pastel drawings that show how the color and light should look in a given scene.

Using the drawings and instructions from the art department, the technical team and model-makers make digital models for the characters. To make the models for *Monsters, Inc.*, they used two processes. Some models were sculpted by hand using clay. They were then three-dimensionally scanned into the computer. Other models were made in the computer. All of them were given avars, which allow the animator to move the character, so the animators could move them later if necessary.

Just as the sets in a live action movie need

PIXAR DIRECTORS: A WINNING STREAK

Lasseter continued to expand Pixar's directorial pool. After Docter directed *Monsters, Inc.*, the next two directors to take charge of Pixar pictures were animator and longtime Pixar employee, Andrew Stanton, and Brad Bird, director of Warner Brothers' *The Iron Giant* and a former classmate of Lasseter's from CalArts.

Stanton's directorial debut, *Finding Nemo*, was released in 2003. The sad but sweet tale of a fish family broke all of Pixar's previous records when it became the highest-grossing animated film of all time. Stanton went on to receive the Academy Award for Best Animated Feature for *Finding Nemo* in 2004.

The Incredibles, directed by Bird, was released in 2004. The funny story about a family of superheroes garnered two Academy Awards. Pixar took gold for Best Animated Film two years in a row when Bird won the award for *The Incredibles*. The movie also won for Best Sound Editing.

to be selected and dressed, or given the right look and props, computer animated movie sets need to be dressed too. The set dressers collaborate with the director on the look of each setting and the movie as a whole. They design the set, or the space that the action is happening in. If the action is happening in a backyard, for example, the set dressers will want to know if the yard should be messy or clean. They could add shrubs, a pool, a barbeque, and yard toys, depending on what the director has in mind.

The layout department is responsible for placing the characters—in this case, the monsters and the children—in the sets and deciding how each shot will look.

Next, the shots are sent to the animation department where animators bring out the characters' personalities, movements, and emotions. Pixar animators used the computer to direct the movements of the monster characters as if they were puppeteers. Because the monsters presented so many new challenges in animating facial expressions and body language, for this movie, each character was assigned a lead animator. The shader and lighting departments then add color, texture, and light to every scene and character.

POSTPRODUCTION

In this final stage, the movie is polished. The director considers the script and characters, the look and the animation, and decides if any changes need to be made.

Then the film is rendered. The data that makes up the film is input into a computer and decoded to create the finished movie. Rendering is very time-consuming and takes a lot of computer power. But over time, it has gotten easier. Today, Pixar renders its movies on a big computer, called Renderfarm. Each frame, which only lasts about one twenty-fourth of a second on screen, takes roughly six hours to render.

Before the film is completed, the editorial department makes any final changes and adds the musical score and the sound effects. Finally, the digital frames, which were prepared during rendering, are

MONSTERS, INC. AT THE ACADEMY AWARDS

The composer Randy Newman won an Academy Award for the song "If I Didn't Have You" for *Monsters, Inc.* In 2002, the movie received three additional Academy Award nominations, for Best Animated Feature Film, Best Sound Editing, and Best Score.

recorded to film by the photoscience department. Most movie theaters only show movies that are on film. When the film is ready, the movie is ready to be screened.

Monsters, Inc. was released in 2001 and reached over $100 million in domestic box office sales in just nine days, faster than any other animated film in history. In 2002, it became the second-highest-grossing animated film of all time, behind Disney's *The Lion King*. +

Composer Randy Newman, *left*, and actor John Goodman performed "If I Didn't Have You" from *Monsters, Inc.* at the Academy Awards in 2002.

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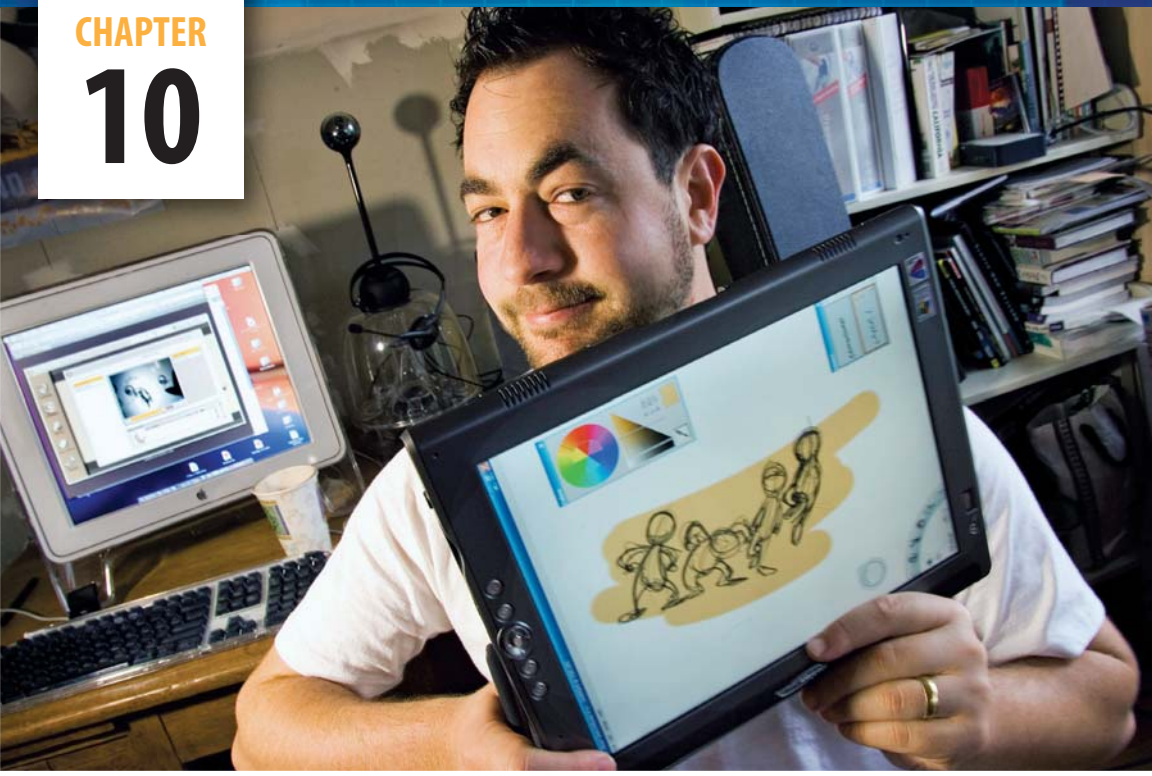

Pixar's animators train students to use tablets and computers to create animations.

PIXAR AND DISNEY

From its earliest days, Pixar was inspired by Disney animation. Lasseter brought his knowledge and passion for Disney's tradition of animation with him to Pixar. He had hoped to bring to computer animation all that he knew about

infusing characters with life. Nearly a decade later, it was Disney that gave a struggling, young Pixar the financing to make the world's first computer-animated film, *Toy Story*.

Soon afterward, as a result of Steve Jobs's successful renegotiation of Pixar's contract with Disney, Pixar's next four films, *A Bug's Life*, *Toy Story 2*, *Monsters, Inc.*, *Finding Nemo*, and *The Incredibles* were all made in an equal partnership with Disney.

CORPORATE COLLABORATION

In 2006, the relationship between Pixar and Disney changed once more. Jobs decided to sell Pixar, and Disney purchased the company for $7.4 billion, all in stocks. Jobs joined the Disney Board, becoming its largest individual shareholder.

Though the two companies had merged, Pixar's offices remained in Emeryville and Disney's in Burbank. Also, Pixar's leadership and talent stayed with the company. Catmull and Lasseter also hired a group of Disney

PIXAR GOLDEN LIONS

Pixar directors John Lasseter, Andrew Stanton, Pete Docter, Brad Bird, and Lee Unkrich received the Golden Lion for Lifetime Achievement at the sixty-sixth Venice International Film Festival.

animators who had recently been laid off, including the codirectors of Disney movies *Hercules*, *Aladdin*, and *The Little Mermaid*.

Catmull's and Lasseter's roles changed with the merger as well. As of 2010, Catmull is president of Walt Disney and Pixar Animation Studios. Lasseter has two job titles. He is chief creative officer of Walt Disney and Pixar Animation Studios and principal creative advisor of Walt Disney Imagineering.

UP, UP AND AWAY

In 2009, Pixar's *Up*, directed by Pete Docter, received five Academy Award nominations, including for Best Picture. This was the first time an animated movie had ever been nominated for this prestigious award. Pixar was very honored to receive the nomination. It meant that the Hollywood community recognized *Up* for its value as a film, not just as an animated movie. Although *Up* lost the Academy Award for Best Picture, the movie won two other awards—Best Animated Feature and Best Original Score.

PIXAR-DISNEY MOVIES

In 2006, the same year as the merger, Lasseter returned to the director's chair for *Cars*. This playful and fast-paced movie was inspired by a family road trip and drew on Lasseter's love of cars and his skill at animating inanimate objects. *Cars* won the Golden Globe Award for Best Animated Film the same year.

Sticking to its goal to make one movie per year, Pixar released *Ratatouille*, directed by Brad Bird, in 2007. The movie, about a rat that is a master chef, was the best-reviewed movie of the year and won the Academy Award for Best Animated Film.

Cars and *Ratatouille* were in various stages of development while the merger was underway. They were the last two Pixar films released under the original Disney Pixar partnership.

Pixar's success streak continued in movies made as a subsidiary of Disney. The first of these was *Wall-E*, a movie set in the future about a robot who is alone on an abandoned Earth covered in garbage. It was released in 2008 and directed by Andrew Stanton. This popular movie garnered Stanton his second Academy Award for Best Animated Film.

In 2009, Docter directed his second movie, *Up*, a charming tale about an old man who used helium balloons to fly his house to South America. This movie too won the Academy Award for Best Animated Feature, Docter's first.

In 2010, Lee Unkrich made his directorial debut with *Toy Story 3*, which was released 15 years after the original *Toy Story* was in theaters. *Toy Story 3* tells the story of the toys when their owner, Andy, is about to leave for college and no longer needs the

toys he played with as a child. The movie broke the record for box office sales of movies that opened in the month of June.

TOY STORY 3 HITS THEATERS

In June 2010, Pixar released *Toy Story 3*, directed by Lee Unkrich. The movie broke all previous box office records for movies opening in the month of June, earning $110 million during its opening weekend.

A COMPUTER ANIMATION LEGACY

Pixar was the first company to make a computer-animated feature, but since then, other companies have entered the field. In addition to *Antz*, Dreamworks SKG created a popular series of computer-animated features that began with *Shrek* in 2001. Blue Sky Studios has also made computer-animated features, including *Ice Age* in 2002. But with hit after hit, Pixar remains a dominant force in the computer-animation industry.

As of October 2010, Pixar is planning three new movies. One is a sequel to *Monsters, Inc*. As they have since the beginning, Pixar animators and technicians continued to work together to solve the technical and creative problems that arise with each new film. The focus remains on the characters and their stories.

This has proven time and again to be a winning formula.

At Pixar, artistry merges with technical prowess. The artistry—Lasseter's realm—is typified by characters with believable emotions, goals, expressions, and movements. The technical prowess is marked by critical problem-solving and ingenuity—skills Catmull has deployed since he first imagined a computer-animated feature more than two decades ago. As a team, Catmull and Lasseter have shaped Pixar—its movies, culture, and commitment to excellence. Their guidance now fuels Walt Disney and Pixar Animation Studios.

PIXAR UNIVERSITY

To attract and train new talent, Pixar started a school called Pixar University in the mid-2000s. New and existing animators can attend three-month-long courses, learning more about computer animation and how to bring characters to life. Courses at Pixar University, located adjacent to Pixar's headquarters in Emeryville, California, include such topics as drawing, screen writing, and filmmaking.

Pixar strives to create an open-minded and experimental environment at the school. The school also gives employees a chance to learn new skills and practice with new technologies.

The dean of Pixar University, Randy Nelson, explained, "If you don't create an atmosphere in which risk can be easily taken . . . then it's likely you're going to be producing work that will look derivative in the marketplace." Of the learning opportunities the university provides, Nelson said, "Those kind of irrational what-ifs eventually lead to something that makes you go, 'Wow, I never would have thought about it.'"[1]

It seems that no problem is unsolvable when it comes to making the best computer-animated movies they possible can. As film critic and animation historian, Leonard Maltin, stated, "They seemed to relish the idea at Pixar of doing something difficult and seeing how to solve the problems in a creative and entertaining way."[2] +

Pixar's Ed Catmull, *left*, and director Pete Docter arrive at the Academy Awards in 2010. Pixar's *Up* was nominated for Best Picture.

TIMELINE

1974	1979	1983
Ed Catmull receives a doctorate in computer science from the University of Utah.	Catmull is hired as director of Lucasfilm Computer Division. John Lasseter graduates from CalArts.	Lasseter begins work at Lucasfilm Computer Division.

1989	1991	1992
Tin Toy wins the Academy Award for Best Animated Short Film.	The Walt Disney Company hires Pixar to make a computer-animated feature film.	Pixar wins the Scientific and Engineering Academy Award for developing Computer Assisted Production System (CAPS).

1984

André and Wally B., a computer-animated short film directed by Lasseter and Alvy Ray Smith, premieres.

1986

Steve Jobs purchases the Lucasfilm Computer Division and the new company is named Pixar Inc.

1986

Luxo Jr., a short film directed by Lasseter, premieres to much acclaim.

1993

Pixar's RenderMan development team wins the Scientific and Engineering Academy Award.

1995

Toy Story is released. Pixar becomes a publically owned company.

1997

Pixar and Disney enter into a new agreement to make five films together and share costs and profits equally.

TIMELINE

1998

A Bug's Life becomes the highest-grossing animated film of the year.

1999

Toy Story 2 is released and breaks opening weekend box office records.

2001

Monsters, Inc., directed by Pete Docter, is released and makes $100 million in box office sales in just nine days.

2006

Disney purchases Pixar from Steve Jobs, and Pixar merges with Disney.

2006

Cars, directed by Lasseter, is released and wins the Golden Globe for Best Animated Film.

2007

Ratatouille, directed by Bird, is released and wins the Academy Award for Best Animated Film.

2003

Finding Nemo, directed by Andrew Stanton, is released and quickly becomes the highest-grossing animated film in history.

2004

The Incredibles, directed by Brad Bird, is released. *Finding Nemo* wins the Academy Award for Best Animated Feature.

2005

The Incredibles wins two Academy Awards, for Best Animated Film and Best Sound Editing.

2008

Wall-E, directed by Stanton, is released and wins the Academy Award for Best Animated Film.

2009

Up, directed by Docter, is released and wins two Academy Awards for Best Animated Feature and Best Original Score.

2010

Toy Story 3, directed by Lee Unkrich, is released and breaks all box office records for movies opening in the month of June.

ESSENTIAL FACTS

CREATORS

Ed Catmull, March 31, 1945

Alvy Ray Smith, September 8, 1943

John Lasseter, January 12, 1957

DATE FOUNDED

January 30, 1986

CHALLENGES

The founders and employees at Pixar dreamed of making computer-animated feature films. When the company started out, this had never been done before. They faced the challenge of inventing ways to fuse the skills of traditional animation with the technology of computer animation. Finding the funding to keep going was also a challenge.

SUCCESSES

When Pixar released *Toy Story* in 1995, it was a big success for the young computer-animation studio. It was the first computer-animated feature film. Pixar's engineers and artists have won numerous technical and artistic awards over the years, and Pixar films have been nominated for and won Academy Awards many times.

IMPACT ON SOCIETY

Pixar has been entertaining audiences with its computer-animated short films and features since its earliest short films. With the release of *Toy Story*, Pixar revolutionized the field of animation.

QUOTE

"When I took that first computer graphics course, then bam, it hit me . . . here's the art and here's the technology, and I reoriented everything around that, and the goal was to make the first [computer] animated feature."—*Ed Catmull*

GLOSSARY

algorithm
A step-by-step mathematical procedure for solving a problem or accomplishing some end, especially by a computer.

character animation
A kind of animation that involves creating characters and giving them movement and personality, such as in cartoons.

compositing
Layering images together using a computer.

computer animation
The process of using a computer to make animation.

computer graphics
Images made with the aid of computers.

digital
Electronic, especially computerized, information.

frame
A unit of film, also can be used to describe the process of choosing the perspective for an image.

hardware
The physical parts of a computer.

modeling
The process of creating 3-D objects for animation.

preproduction
The development, research, and preparation stage of filmmaking.

procedural animation
A kind of animation that is generated by a computer program or code.

production
The stage of filmmaking when the movie is made.

render
To take computer data and execute it in a program to generate a frame. Twenty-four frames are used per one second of film. Many frames are rendered to make one film.

shader
An algorithm that defines the way light reacts to a 3-D surface of computer geometry. Different shaders are used for different surfaces, such as glass, plastic, or rock.

shot
One of many setups, settings, or arrangements of objects or characters for a film.

software
Programs used to direct the operation of a computer.

storyboard
A drawing or sequence of drawings that show the shots and actions that will be in the frame, including camera moves in a film.

ADDITIONAL RESOURCES

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Stanton, Andrew. *Pixarpedia*. New York: DK, 2009. Print.

WEB LINKS

To learn more about Pixar, visit ABDO Publishing Company online at **www.abdopublishing.com**. Web sites about Pixar are featured on our Book Links page. These links are routinely monitored and updated to provide the most current information available.

PLACES TO VISIT

ASIFA-Hollywood Animation Archive
2114 West Burbank Boulevard, Burbank, CA 91506
818-842-4691
http://www.animationarchive.org
A nonprofit educational organization that hosts a museum, library, and digital archive for animation professionals.

Disneyland
1313 South Harbor Boulevard, Anaheim, CA 92802
714-781-4565
http://disneyland.disney.go.com
John Lasseter, the creative force behind Pixar, advises the Imagineers who build rides for Disneyland.

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ABOUT THE AUTHOR

A. M. Buckley lives and works in Los Angeles. She is the author of several books for children. She particularly thanks her husband, a graduate of CalArts in Experimental Animation, for many long and fascinating talks about animation and technology while she was researching and writing this book. Buckley's favorite Pixar films are *Red's Dream*, *The Incredibles*, and *Up*.

PHOTO CREDITS

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