



BEHIND THE SCENES & AHEAD OF THEIR TIME

Working from both sides of the camera lens, innovative women seized new technologies and transformed how movies look, feel, and entertain.

By Seabright McCabe, SWE Contributor

When STEM and the arts collide, creative disruption can change everything. Film is a prime example — constantly reinventing itself with new technology and using it to tell human stories. Though the film industry has largely been male dominated (except for a brief period in the 1920s and early 1930s), women have always found ways to use and even invent technology to make art.

Alice Guy-Blaché loved books, theater, and science and was a natural storyteller. In 1895, she attended a Paris demonstration of the Lumière brothers' newly invented Cinématographe camera. The Lumières' short *actualité* film showed a group of factory workers leaving a plant. Guy-Blaché immediately saw film's potential for creating entertaining stories — and was convinced she could do better.

A secretary with no technical training, she asked her employer, movie camera inventor Léon Gaumont, if she could try filming a scene. In *The Memoirs of Alice Guy-Blaché* (Rowman & Littlefield, 2022), she recalled him saying, "It seems like a girlish, silly thing to do, but you can try if you want. On one condition: that your office work doesn't suffer."

Guy-Blaché, the world's first known woman filmmaker, was running Gaumont's movie studio within a year. As a writer, producer, and director, her filmography would grow to between 600 and 1,000 films. She almost single-handedly took the medium from a technical novelty to an enduring artform, even producing sound-enhanced films.

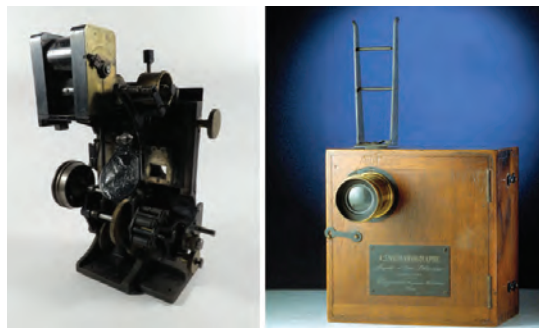
Guy-Blaché immigrated to the United States from France in 1907, where she co-founded the motion picture studio Solax Company in 1910. Though she is largely forgotten today, she is said to have defined the basics of cinematic language, camera angles, and editing that influenced many future filmmakers, including Alfred Hitchcock.

Finding her light

In the mid-19th century, theatrical lighting was primitive. Gas-burning lamps eventually gave way to blocks of lime, which — when heated sufficiently — emitted a bright white "limelight," backed by a reflector to control its direction. These fixtures became front lights, follow spots, and special effects suggesting fire and water. After Thomas Edison invented the light bulb, incandescent stage lights replaced limelight in theatrical productions. But they were dim, heavy, and, because of their delicate carbon filaments, virtually immobile.

Enter Maude Adams, America's most beloved stage actress at the time, who originated the role of Peter Pan on Broadway in 1905. Fascinated by lighting technology and set design, she began working with technicians and engineers on her productions. Along with electrical and lighting engineer Bassett Jones, she developed new stage lights that were smaller, lighter, and brighter. Adams was also credited with inventing a "light bridge," which held seven incandescent spotlights on a 37-foot truss suspended above the stage. The bridge diffused light evenly across the stage, eliminated shadows, and rendered footlights obsolete overnight.

After retiring from acting in 1919, Adams turned her attention to movie production. She leveraged her wealth and fame, hiring a research team to help her develop stronger incandescent lighting. Adams attracted the interest of General Electric, which had just invented a tungsten filament bulb, and Eastman Kodak, which wanted to use her lights with its new Kodachrome color system. In 1922, this three-way collaboration resulted in the world's largest incandescent lamp. At 18.5 inches high



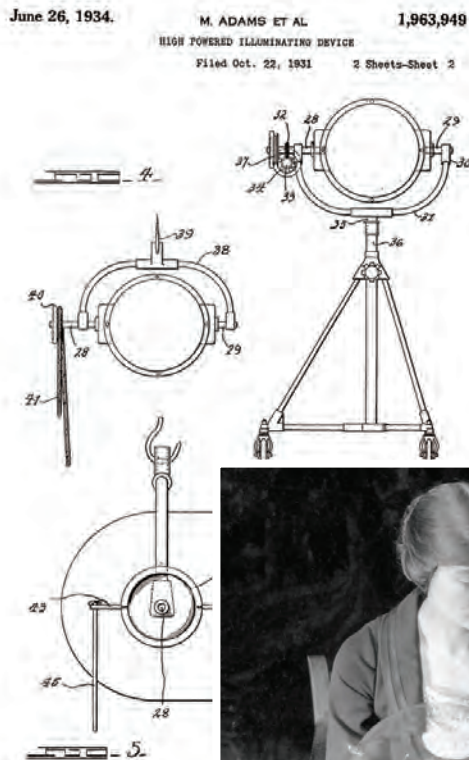
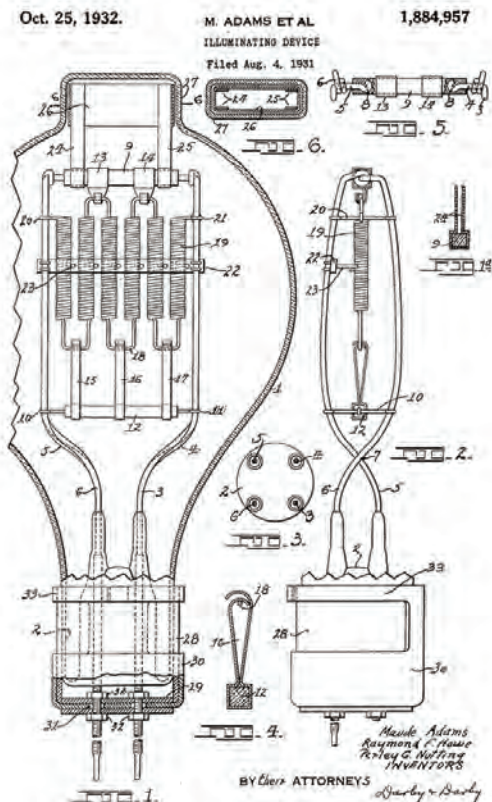
The Cinématographe motion picture camera was invented by Auguste and Louis Lumière and first demonstrated in Paris in 1895.



Alice Guy-Blaché was likely the world's first woman filmmaker and invented a cinematic language as she learned to navigate new technologies.

and with a 12-inch diameter bulb pulling 30,000 watts, it emitted an astonishing 60,000 candles' worth of light.

Adams' lights sparked a new industry standard in Hollywood with the advent in the late 1920s of sound in films and in the 1930s of color photography under artificial lighting. Her name is on several patents relating to high-powered incandescent lighting, including one for a method for supporting the filament so that the lamp could be tilted, one for a support for the filament to make it efficient and rugged in construction, and one for a method for cooling a high-powered lamp. Her combination of technical curiosity, artistic experience, and collaborative approach was unique. After Adams' death in 1953, Jones said: "She completely revamped the whole art of stagecraft — setting and lighting. ... In my opinion, Maude Adams was the greatest production artist this country ever saw."



RIGHT: Actress and inventor Maude Adams developed the world's largest incandescent lamp in collaboration with General Electric and Eastman Kodak in 1922. ABOVE: Adams held several patents for early lighting technology.

Hollywood's golden age

Women ran the table during the silent film era of the 1920s — partly because during World War I women stepped into roles traditionally held by men but also because women made up the majority of the moviegoing public. Women like Mary Pickford, who co-created the United Artists studio, were consistently the highest-paid performers, top screenwriters, and star producers and studio innovators, creating stories in which women could see themselves jumping off a moving train instead of being tied to the tracks. Women of color also made their marks with historic firsts: Marion E. Wong started the first Chinese American movie company in 1917 and produced, directed, distributed, and acted in a feature film. Tressie Souders was the first known Black woman to direct a film, *A Woman's Error*, in 1922.

Eloyce Gist followed in the late 1920s and early '30s, making short, low-budget, 16 mm films with her husband, James Gist, that focused on moral education and the spiritual enrichment of Black communities.

From the 1920s to the early 1940s, Dorothy Arzner worked her way up from film editing to become one of the only woman directors working in Hollywood at the time. She was the first woman to join the Directors Guild of America, the organization representing the interests of film and television directors, and she remains "the most prolific woman studio director in the history of American cinema," according to the Women Film Pioneers Project, a partnership with Columbia University Libraries.

Arzner also solved technical problems on the set. When sound revolutionized the industry in the late 1920s, silent film

stars struggled to adjust to microphones and recorded dialogue. Arzner, the first woman to direct a "talkie," had one such star in her film, *The Wild Party* (1929), the quintessential flapper Clara Bow. Hollywood's "It Girl" was famous for her energetic acting style and couldn't hold still long enough for a stationary mic to pick up her words. So Arzner tied a microphone to a fishing rod and followed her around with it — creating the boom mic we know today and the command shouted by countless film directors, "Lower the boom!"

Gloria Swanson, inventor

Gloria Swanson is best known as the fabulous (and terrifying) Norma Desmond in the noir classic, *Sunset Boulevard*. But she also had a keen interest



WOMEN FILM PIONEERS



Gloria Swanson, best known for starring in *Sunset Boulevard*, was also an inventor and entrepreneur.



Filmmaker Dorothy Arzner worked with Roaring '20s star Clara Bow, shown in 1929.

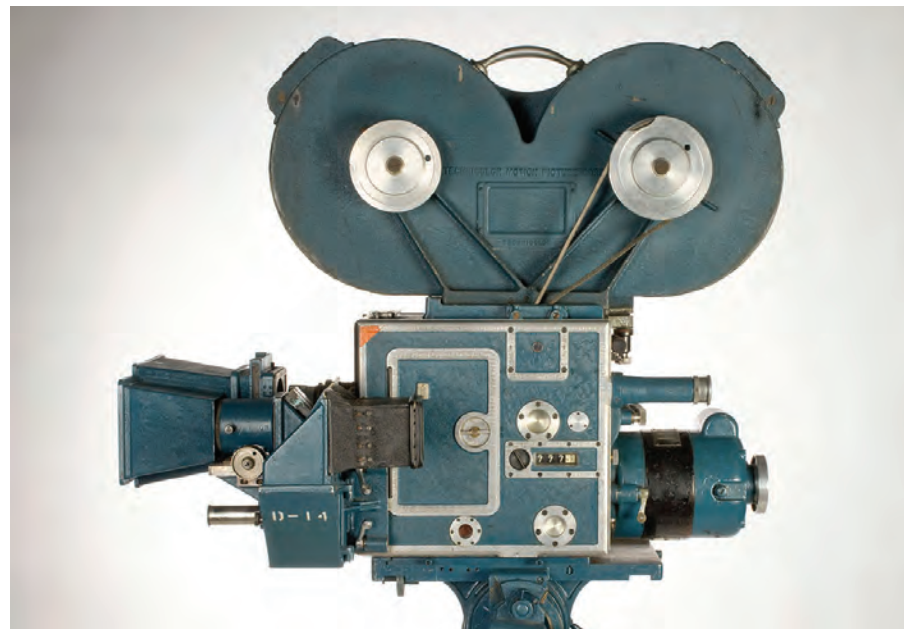


Natalie Kalmus led the color consultancy department of Technicolor and served as color director on more than 400 films.

in science and an engineer's knack for technical invention. An avid reader of *Popular Mechanics*, Swanson once said, "I've always had a mechanical mind, wanting to know the 'why' of things. I guess you'd call it an instinct rather than actual knowledge."

According to biographer Stephen Michael Shearer, Swanson had a great interest in materials science, especially plastics, metals, and liquids she could use to invent fashions, jewelry, and art pieces. She also tinkered with developing a long-lasting luminous paint, thinking that it would be useful for the film industry and possibly the U.S. military.

In 1939, Swanson founded Multiprises,



Technicolor's three-strip camera was used to give *The Wizard of Oz* its breathtaking hues.

a profit-sharing startup that pursued patents and markets for inventions and was staffed by scientists she rescued from Nazi-dominated Europe. Using her star power, she secured visas for experts in plastics, metallurgy, electronics, and acoustic engineering and put them to work. During the company's brief run, Swanson and her team invented a carbide steel alloy cutting tool, the first plastic buttons for clothing, and, remarkably, the extension cord. Swanson never stopped inventing and pursuing new ideas. Later she began to explore a photography process that could print images on fabric and even drew up plans for a water-saving toilet.

'Ringmaster to the rainbow'

In 1939, Dorothy woke up, and the world was never the same. Audiences gasped at the transition from sepia to brilliant color in *The Wizard of Oz*. Though it wasn't the first use of Technicolor's revolutionary three-strip process, it remains one of the most remarkable because of one woman's technical knowledge and flawless aesthetic.

Natalie Kalmus led the color consultancy department of Technicolor,

serving as color director for her husband Herbert's company from 1934 to 1949. She was the last word in visual storytelling for more than 400 films, describing her work as "playing ringmaster to the rainbow." And she wasn't afraid to get in shouting matches over color choices with directors, some of whom came to loathe her.

Before her husband's invention, color film was hand-painted frame-by-frame or projected through colored lenses, resulting in a small range of unnatural hues. Technicolor changed all that when Herbert Kalmus commissioned the building of a new camera and a modified dye transfer system. Both would accommodate three strips of film, separate negatives in red, green, and blue. The camera could photograph three strips in these primary colors, while the subtractive dye transfer process allowed complementary colors — cyan, magenta, and yellow — to be set on one highly durable strip of film.

Demand was instant. Technicolor became the gold standard in the movie industry until Eastman Kodak came up with a simpler, cheaper, and less durable system in the early 1950s. In her industry



Sara Bennett, VFX producer, won an Oscar for 2015's *Ex Machina*.



Marion E. Wong founded the first Chinese American film studio in the United States in 1917.

bible, *Color Consciousness*, Natalie Kalmus explained color theory as being as much about the “why” as the “how.”

“We see that all the colors in the spectrum speak their particular language,” she wrote. “The flush of anger, the vigor of a sun-tanned skin, the richness of gold velvet, the violet mystery of distant mountains, the serenity of blue sky — these colors alone speak with more eloquence than could be described by words.”

Natalie Kalmus paved the way for another innovator, Beverly Joanna Wood, who guided cinematographers through the transition from chemical to digital technology, decades later. A chemist and engineer, Wood was instrumental in creating and developing color contrast enhancement and adjustable contrast enhancement processes, designed in collaboration with filmmakers. In 2020, the Society of Motion Picture and Television Engineers presented Wood with the Technicolor Natalie M. and Herbert T. Kalmus Medal for her contributions.

Cue the cutters

Though avenues for women in technical roles in Hollywood narrowed as men returned from two world wars, their talents found a place in film editing. The art of cutting and splicing thousands of feet of footage into a clear narrative was tedious, painstaking work that most people weren't interested in doing. Women stepped up and were instrumental in film editing throughout the

1920s, '30s and '40s. Florence Osborne wrote in a 1925 *Motion Picture Magazine* article: “Among the greatest ‘cutters’ and film editors are women. They are quick and resourceful. They are also ingenious in their work and usually have a strong sense of what the public wants to see. They can sit in a stuffy cutting room and see themselves looking at the picture before an audience.”

Filmmaker Su Friedrich, who created a database at Princeton University of films edited by women, said, “Women were hired ... because it seemed like a job that women did the way women did sewing. You know, ‘they’re good with their hands,’ this sort of ridiculous idea.” Friedrich also said that notions like this also kept women out of other industry jobs, such as directing and cinematography.

Legendary film editor Margaret Booth, best known for editing and co-writing *Mutiny on the Bounty*, believed good directors each had a rhythmic visual style and it was the cutter's job to find that rhythm. “Before we had Moviolas for editing, we would run the pieces of film through our fingers. I would count, as if I were counting music, to give the scene the right tempo,” she said, according to the Women Film Pioneers Project.

Booth rose to supervising editor at Metro-Goldwyn-Mayer Studios, overseeing all the studio's editors until 1969. Many women editors enjoyed prominent positions in the film industry in the decades that followed.

Those who have seen David Lean's 1962 epic masterpiece *Lawrence of Arabia* know the moment when a closeup of a lit match cuts to an extreme long shot of a desert sunrise. In a 2010 interview, film editor Anne V. Coates, described working with Lean to get its timing just right. “We decided to nibble at it, taking a few frames off here and there,” she said. “David looked at it and said, ‘It's nearly perfect. Take it away, Annie, just make it perfect.’ So, I took two frames off, and he said, ‘That's it.’ Visually it was so effective and dramatically so right.” Coates won an Oscar for film editing for *Lawrence*, and the moment is regarded as the greatest “match cut” in movie history.

Similar to the percentage of women engineers in the workforce, 26.5% of film editors today are women, according to the demographics site Zippia.com. And in the modern era, women edited such blockbuster movies as *Jaws* (1975), *Star Wars* (1977), *Platoon* (1986), and *The Departed* (2006).

VFX, CGI, and world building

From the very first films, visual special effects, or VFX, have been a hotbed of innovation. Early efforts were mostly practical — miniature models, rotoscopes, rear projection, matte backgrounds, and stop motion animation were painstakingly done by hand. Mechanical and electrical engineers were and are still needed to make props move, burn, fly, or blow up safely.

Computer generated images, or CGI, arrived in the 1980s with *Star Trek 2: The Wrath of Khan*, the first movie to feature a completely computer-generated scene. Just as sound and then color film revolutionized the industry, CGI opened up whole new worlds.

So did 3D technology. Modern 3D blockbusters like *Avatar* and *Dune* owe a debt of gratitude to NASA physicist Valerie Thomas, Ph.D., whose invention, the “illusion transmitter,” is the basis for 3D movie projection. Dr. Thomas' transmitter used a video recorder to take

a picture of a floating image in front of a concave mirror. The video image was sent to a second camera, which projected the image in front of a second concave mirror. This process created the optical illusion of a 3D image, hanging in space. Dr. Thomas received a U.S. patent for her invention in 1980, and the technology is being adapted for video and television screens and for use in surgical tools.

Today, 26.1% of the VFX community is female, according to Women in Animation, including a number of trailblazers. Suzanne M. Benson, one of the VFX producers responsible for the frightening, toothy creatures in *Aliens*, became the first woman to be nominated in the best effects, visual effects category and went home with an Oscar in 1987.

Sara Bennett was the first woman VFX supervisor to win an Academy Award for her work on the sci-fi hit, *Ex Machina* (2015). The film centers on female robot Ava, played by Alicia Vikander, whose body has humanoid features but with a transparent skull, limbs, and torso. The effect was generated through a combination of prosthetics and CGI, seamlessly blended by software with film of the actress. Bennett, whose body of work includes the first four Harry Potter films, went on to co-found her own studio, London-based Milk Visual Effects.

Though women in entry-level VFX positions are few and far between, one VFX leadership role is close to gender parity, according to the nonprofit advocacy group, Women in Animation. Visual effects producers work closely with the VFX supervisor, the on-set crew, and postproduction teams, making sure work is delivered on budget and on time. From 2016 to 2019, 47% of VFX producers were women, Women in Animation reports.

CGI is time-consuming and expensive to produce. According to the Academy of Animated Art, each Marvel movie spends a staggering \$100 million to \$200 million on special effects. More VFX innovations are beginning to disrupt the industry, streamlining production and



NASA physicist Valerie Thomas, Ph.D., invented an "illusion transmitter," which formed the basis of 3-D movie technology.

potentially reducing costs. Epic Games' software, Unreal Engine, is already in use in the architecture, engineering, and automotive industries. With its ability to instantly render real-time virtual worlds, it may be the next big leap for cinema.

We can only imagine what Alice Guy-Blaché, who blew up an actual ship off

the coast of New Jersey for a film in 1913, would do with this technology were she working today. It's up to a new generation of women making film history to show us what the future of movies will be like with 3D, streaming, and virtual/augmented reality poised to reinvent the industry yet again. ✨

For more entertainment

Learn more about Unreal Engine and its eye-popping capabilities:
youtube.com/watch?v=F0VPIEL72T0

Pop it full screen and watch Anne V. Coates' genius match cut from *Lawrence of Arabia*: youtube.com/watch?v=HlUFX00wxVQ