

DIGITAL TAKE 2

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COMPUTERIZED
POSTPRODUCTION
IS SILENTLY
TRANSFORMING THE
MOVIES
AND GIVING
FILMMAKERS
A WHOLE
NEW SET OF
CHALLENGES.

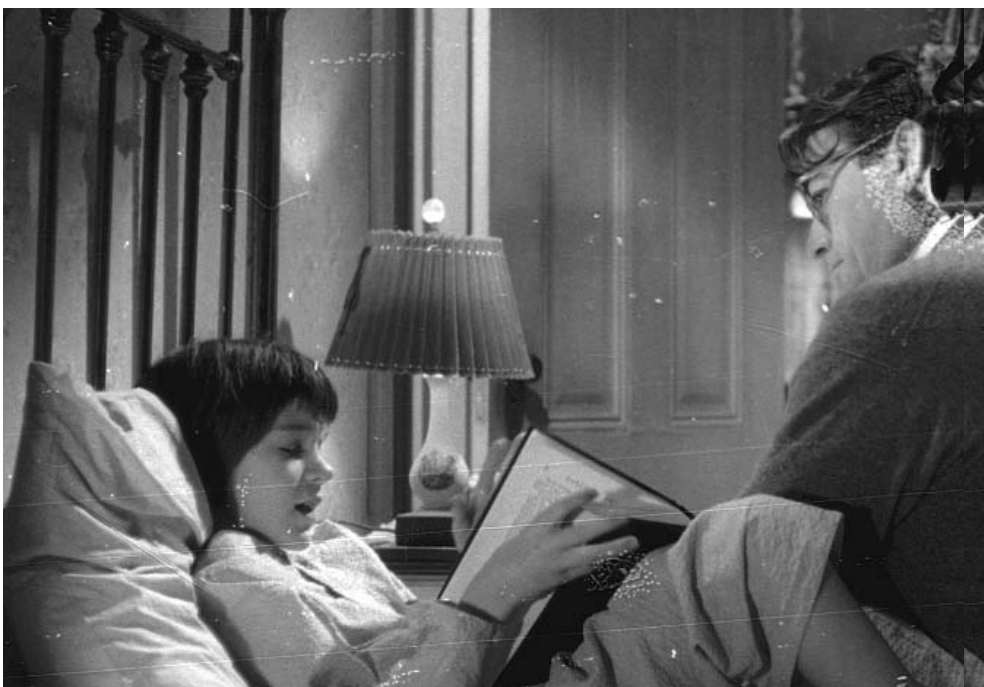


Image engineering: Digital artists turned lush fields dry for *O Brother, Where Art Thou?*, created a pristine print of *To Kill a Mockingbird* and synthesized much of the desert island in *Cast Away*.



Hollywood being a star-making machine above all else, it was not surprising that the buzz on 2000's release of *Cast Away* was all about the weight Tom Hanks gained and then dropped to give life to his character's years of privation.

The real magic behind the film wasn't revealed until much later—that the island peak over which the hero clambered was a mud pile overlooking a California parking lot, and that much of the tropical environment seen on screen, from breakers to mountaintop, had been fashioned inside a computer.

Reliving the production, George Joblove breaks into a delighted grin. "Any shot that had ocean or sky in it," says the senior vice president for technology at Sony Pictures Imageworks, which created the visuals, "was pretty much a special effect." The film's software-generated scenes not only featured action and compositions that would have been impractical and expensive to shoot on location, but also contained elements such as windstorms and enormous waves that are virtually impossible to create in the real world.

That a tropical island could be manufactured so seamlessly out of pixels and algorithms testifies to the ascendancy of digital technology in Hollywood, where it has all but superseded the optical and photochemical manipulations that were state of the art as recently as 10 years ago. It's no secret that 3-D digital processing is responsible for some of the grandest effects of modern blockbusters, beginning with the dinosaurs of *Jurassic Park* and leading up to the careening space runabouts of *Star Wars: Episode II—Attack of the Clones*. But what's more remarkable is how thoroughly digital technology has taken over film editing, color adjustment and other components of the so-called postproduction process—including the subtle alterations, such as the erasure of television antennas from period backgrounds and support cables from acrobatic stuntmen, that lend verisimilitude to everything from drawing-room pieces to psychological dramas.

"We call them 'invisible effects,'" says Joblove, speaking from an office that overlooks the six-hectare Sony Pictures Entertainment studio complex in Culver City, CA. "Most are things you shouldn't notice and shouldn't know about, things that shouldn't draw attention to themselves."

Indeed, without most moviegoers' noticing, digital technologies have been slowly supplanting film-based processes that have been used since the 1920s. Imageworks' vice president of marketing and communication Donald Levy estimates that the movie industry now spends roughly half a billion dollars per year on visual effects—almost all of them digital. At many postproduction houses chemistry labs have given way to programming carrels in which computer science graduates write algorithms that will eventually simulate the wash of waves on a beach or the separation of a Saturn V rocket from its Cape Canaveral gantry—artists working in code rather than pen and ink.

And today there is scarcely a film lab in Hollywood that does not offer digital services—up to and including the restoration of archival films—to its industry clientele along with traditional developing, color timing and print services. One of the fastest-growing business lines at Technicolor, which pioneered the first two-color photochemical process in 1916, is the digital scanning of film prints in order to insert visual effects. Kodak, which sells some 80 percent of all the film stock used in U.S. movies, has hedged its bets by opening Cinesite, a Los Angeles- and London-based subsidiary that has become one of the most important and innovative purveyors of digital services—such as digital editing, special effects, and the creation of digital master copies of negatives and prints—to moviemakers.

But while large-scale digital modification of images is already rife in Hollywood, it has its limits. Clean digital files and hidden microchips haven't quite replaced reeking photochemical emulsions and temperamental celluloid stock, and the unalloyed enthusiasm many filmmakers felt for the new technology just a couple of years ago has evolved into a mature assessment of it as one tool among many, both novel and traditional. Directors and cinematographers who have worked in the new medium have generally found that its flexibility, while valuable, also comes at a steep cost.



Digital journey: Film negatives arrive at Kodak's Cinesite facility (left) and are transformed into digital masters by scanning experts (right).

PREVIOUS SPREAD: COURTESY OF TOUCHSTONE PICTURES (O BROTHER, WHERE ART THOU?); COURTESY OF CINESITE (TO KILL A MOCKINGBIRD); COURTESY OF SONY PICTURES IMAGWORKS (CAST AWAY)



Reel to unreal: Even the fastest film scanners, like this 70-millimeter version at Cinesite, need days to digitize an entire movie.

Take Roger Deakins, an award-winning cinematographer who used digital technology to great effect in creating the distinctive look of the Joel and Ethan Coen Depression-era film *O Brother, Where Art Thou?* Deakins and the Coen brothers were determined to evoke the Dust Bowl by giving the whole film the faded look of an old-time picture postcard. This involved, among other effects, transforming the lush greens of vegetation into a sere tobacco-yellow in the film's exterior shots. While the judicious deployment of lighting and lens filters would have had the same effect, it would also have given other colors, especially skin tones, an unnatural tint. Instead, Deakins shot the entire film conventionally and had his negative digitized at Cinesite, where technicians then helped him tint out the greens without affecting the rest of the palette by adjusting the digital values of the pixels in each image—much the way audio engineers can boost the bass of a recording without changing the treble or midrange.

Although the process sounds straightforward, it was much more demanding than conventional photography.

Among other things, Deakins realized that he should invest his negatives with the most highly saturated colors possible, to give the technicians the maximum amount of information to work with during the color correction process. At Cinesite, he supervised the alterations like a mother hen watching over her chicks.

"I was there every day for more than 10 weeks, from testing with camera negatives until the first print was out of the lab," Deakins says. This was necessary in part because the entire project was novel, even for Cinesite. But Deakins feels that because of its very power, digital color correction demands particular watchfulness. "There's so much that can be done with the technology that if you as a DP [director of photography] aren't there, your work easily could be ruined."

In the end, he concluded that such so-called digital mastering (the conversion of a sequence or an entire film to digital form) is useful only in special circumstances—as when striving for an effect that can't be reached through conventional means. "It

depends on what's right for the project, because I don't think the quality is as good as film. If you're not going outside straight RGB [red, green and blue] timing, I don't see much point in going the digital route."

"There's a tremendous amount of hype around the word 'digital,'" agrees Steven Poster, president of the American Society of Cinematographers. As director of photography on Sony's summer release *Stuart Little 2*, Poster also used a digital master in postproduction, since almost every frame includes the film's title character—a mouse created entirely in digital form—or one of his digital pals. "There are certain skills necessary to accomplish the shooting, making and coming out on the other end with a motion picture," Poster says. "One is cinematography. We say, if you know how to light it doesn't matter what medium you're shooting on. Likewise, if you don't know how to light it doesn't matter which medium you're shooting in." Today's filmmakers, in other words, must master not one technology but two—and then be willing to spend long hours bridging their incompatibilities.

FILM'S FIRM FOOTHOLD

The best way to grasp the degree to which digital technology has infiltrated moviemaking is to partition the life cycle of a feature into three phases: image acquisition (known in simpler days as "photography"), postproduction and exhibition.

Electronic technologies have made remarkable progress on some of these fronts—but overall, cinema hasn't changed as much as you might expect from all of this summer's buzz about digital movies. Most principal photography is still done on film, despite George Lucas's decision to shoot *Star Wars: Episode II* entirely using digital cameras. Cinematographers agree that digital hardware is getting vastly better, aided by the emergence of the so-called 24p process, which allows high-definition digital video to be shot at film's 24 frames per second, rather than the roughly 30 of conventional video (thus eliminating the need for complicated adjustments of frame rates). But even the best digital imagery still doesn't approach film's resolution and dynamic range in terms of color and contrast.



Dialing tones: Colorist Jill Bogdonawicz and her dad Mitch, a Kodak researcher, apply color effects in the Datacine suite.

"There's still room in film to carry information beyond the capability of the eye to see it," says Brad Reinke, manager of digital restoration services at Cinesite. "Digital's not nearly there."

At the other end of the production process—your neighborhood movie theater—digital technology has barely made any headway. As of this summer only 100 or so of the country's 35,000 screens were equipped for digital movies—whether downloaded via satellite or spooled off high-density digital discs resembling DVDs. Those that were used a Texas Instruments system based on arrays of microchips, each with about a million microscopic mirrors that pivot toward or away from the screen thousands of times per second (see "Digital Movie Projection," *TR March 2001*). Digital projection is jiggle free, and unlike film projection, it doesn't degrade the print with every showing. But in part because digital projection does not create as unmistakable an improvement in the viewing experience as, say, the talkies did over silent films, theater chains are unwilling to foot the bill for the new projectors, which cost at least \$100,000 per screen and might have to be upgraded every few years. Conventional film projectors, which last 20 years on average, cost \$30,000.

"Digital cinema could never drive enough extra traffic through our box offices and to our concession stands to make up the difference," John Fithian, president of the National Association of Theater Owners, told a Washington, DC, technical conference last year.

Still, almost everyone in Hollywood agrees that in post-production, digital is well on its way to becoming the state of the art. Film editing today is done almost entirely through virtual cutting and pasting on video screens, which replaces the tiresome manual method of slicing up celluloid film strips and splicing them back together with tape.

COMPLEX FX

Special effects—everything from plane crashes to acrobatic stunts to alien life forms—are now customarily computer generated, thanks to software tools like Pixar's RenderMan, or like Maya, perhaps the most widely used application for 3-D imaging. The product of Silicon Graphics subsidiary Alias/Wavefront and a direct descendant of the program that produced the dinosaurs of *Jurassic Park* in 1993, Maya is esteemed by digital-effects teams not only for its comprehensive scope and power, but for its compatibility with the special-purpose "plugins" (mini-programs that interact with and enhance the main software) that special-effects departments often devise to meet particular needs on feature projects. It's not unusual to hear visual-effects artists comparing the merits of, say, the ocean effects plug-in Imageworks devised to generate the breakers and swells in *Cast Away* and the one developed by Warner Brothers for *The Perfect Storm*.

Even more remarkable is the extent to which digital artists are using their tools to give life to animated characters. Every year brings improvements in the rendering of movement and organic textures like skin and hair. "We do almost all our modeling and character animation with Maya," Sony's George Joblove is explaining one afternoon as he escorts me past the darkened warrens of Imageworks' animation floor, where the finishing touches are being made on *Stuart Little* 2 weeks before its



Rack room: Playback decks feed data to Cinesite's editing suites.

scheduled release. He pulls aside a curtain to reveal a glimpse of a Maya artist working on a scene a few seconds long in which a complacent Stuart Little is suddenly snatched out of the frame by a set of talons. The scene plays over and over again as the artist refines the details.

"We have more than two dozen software engineers," Joblove continues as we tour this particular nexus of the Hollywood Hills and Silicon Valley. At any given time, he notes, some might be deployed to work on the effects for a single film, others on software that the firm will use on dozens of projects. Some of these, such as code writers and database specialists, can be found in any highly computerized organization; others, the more artistic, have expertise that can only be found in a facility like Imageworks.

I ask which is more important, artistic talent or coding skills.

"We span the whole spectrum—people who are just engineers and couldn't draw a stick figure, and others who are talented artists and never used a computer before they came here. And in the middle," says Joblove, "are a few people working on shots who have a strong and deep understanding of the science and the software and the art."

This precious breed is actually becoming more and more common in Hollywood, fueling a range of digital-movie companies from Efilm, which has developed its own laser recording technology for transferring digital images back to film, to Rhythm and Hues, where one specialty is animating unusual characters such as *Harry Potter's* Sorting Hat—a mouthy piece of millinery that, in the judgment of the *New York Times*, had "more personality than anything else in the movie" (see "Digital Movie Stars," p. 43). But it may be at Cinesite's hangar-sized facility, a few miles north of Imageworks and not far from the corner of Hollywood and Vine, that the virtues of digital postproduction are most vividly on display—along with the difficulties.

The compromises begin in Cinesite's scanning room, where technicians convert film images to streams of digital bits by playing a laser beam over the original frames. Because digital video images have an inherent "edginess," film converted to video at the standard resolution (2,048 pixels wide by 1,556 deep, known as "2K") tends to look somewhat soft focused. That failing can be overcome by scanning at 4K—roughly 4,100 pixels across by 3,000 deep—but this generates a data file so big that a standard

feature film would take 12 full days to scan. The larger digital files also impose a huge cost in storage requirements and processing time. Since the difference in image quality is almost imperceptible in a movie theater, 4K is only used for the most exacting projects, such as the conversion of *Fantasia* and *Apollo 13* for Imax presentations, where the giant screen would render even a minute loss of detail spectacularly visible.

After they leave the Cinesite scanning room, digital files continue along any of three production routes: to the insertion of visual special effects; to digital mastering, which allows color correction and conversion to DVD or video formats; or to the company's restoration service. The special-effects artists, who must carefully integrate the computer-generated objects in a frame with the real ones, get much of the glory once a film's publicity is under way. But the color timers and other professionals who oversee digital mastering probably contribute more to a film's overall look. During mastering, Cinesite's technicians use Kodak's Cineon system to adjust color values to avoid distracting video phenomena such as banding, in which slight gradations of brightness create contour lines, and clipping, in which the detail within bright images bleaches out. By adjusting the brightness of digitized images to a logarithmic curve—compressing the amount of information at the dark end of the scale and expanding it at the bright end—the system “matches the eye's perception,” explains Steve Wright, Cinesite's technical director for 2-D.

RESTORED TO LIFE

But it may be Cinesite's digital restorationists who work the biggest technological miracles from day to day, making old, unviewable films look as new as they did the day they were printed. Restoration, in fact, is the one area where digital technology is close to an unadulterated blessing, for it gives technicians an unprecedented ability to remove defects caused by production mistakes or the ravages of time.

In a room rimmed with computer workstations, Corinne Pooler is painstakingly restoring a sequence from the classic 1962 film *To Kill a Mockingbird*, which Universal Studios is plan-

ning to rerelease in a pristine theatrical print. Because *Mockingbird*'s original negative had been damaged beyond usability, the restorers are working from two fine-grain prints unearthed in Europe and the United States and subsequently digitized by the company's scanners. Each print has its own myriad imperfections, however, which presents Pooler with the challenge of assembling one clean print from the undamaged portions of the two others.

The secret weapon is another program called Moviepaint, which Kodak specifically designed for Cinesite. On her monitor, Pooler displays a frame showing a clapboard house on the left, the branches of a spreading oak on the right, and along the frame edge the large, ugly blotch that is her quarry. Pooler carefully aligns the digital image of the previous frame over the stained image. Then she launches a function that allows her to import the pixels from the clean frame into the stained image, in effect erasing the blotch.

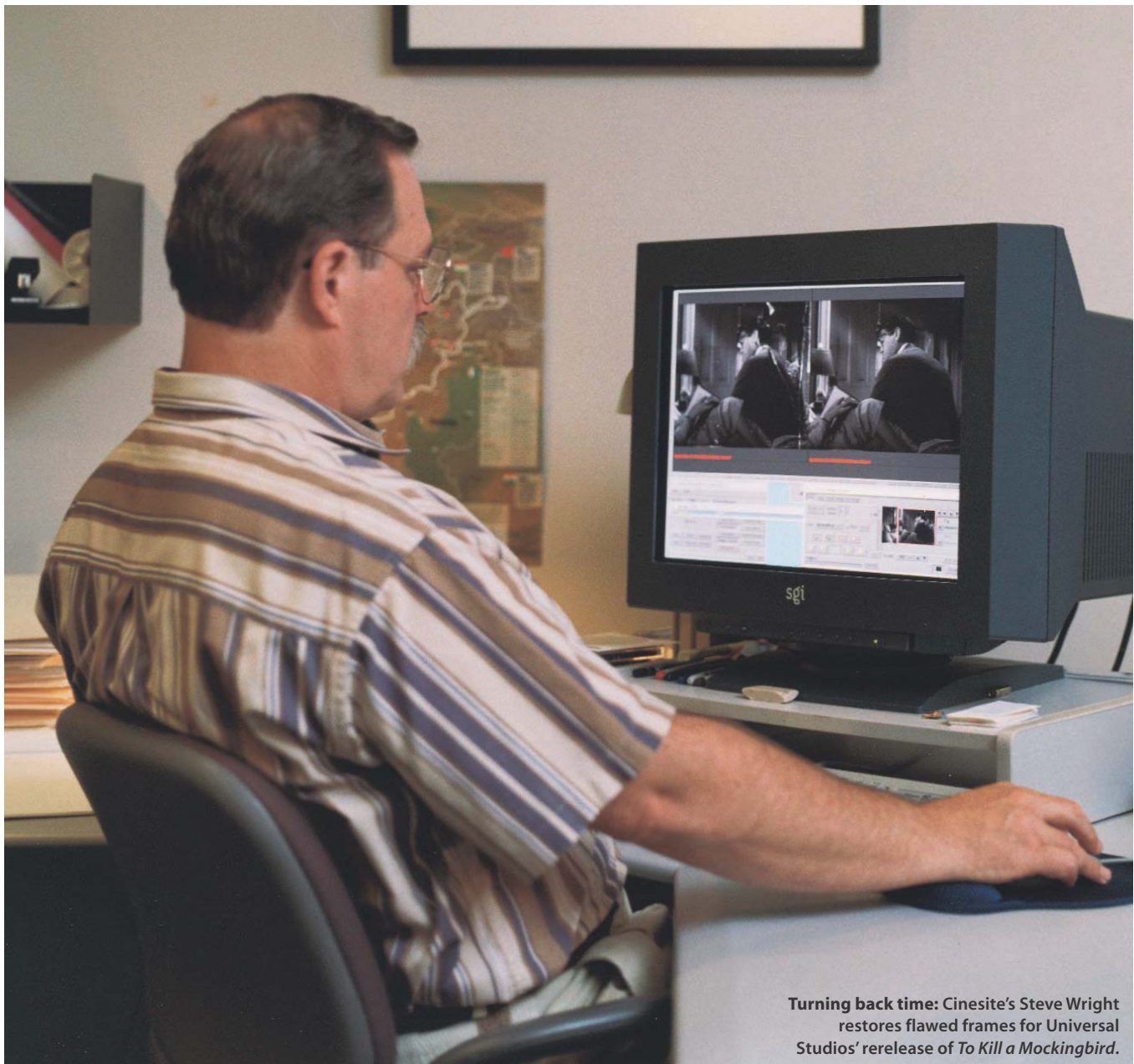
“It can be tedious,” she says of a process that will have to be repeated, with minute variations, on thousands of scratches, stretches, dust globs and breaks. (A Cinesite program called Bitzer automates much of that process, but only manual work using Moviepaint can correct every flaw.) Pooler, nevertheless, is well aware that she holds a job that would not exist at all but for digital technology. Seven years ago, she explains, she was a housewife with a job with her local school board. As it happened, her husband, Jerry Pooler, creative director for digital restoration services at Cinesite, was beginning work on the restoration of *Sleeping Beauty*.

“I was off for the summer, and Jerry needed people to help paint out dirt hits,” Corinne recalls. “He told me, ‘If you can paint 150 frames a day we’ll keep you. If not, I’ll have to fire you.’” Pooler had no training in art or computer science, but she did have an eye instinctively capable of distinguishing between the minuscule details on a frame that are actually part of the image and the imperfections that call for obliteration.

In this craft an innocent misjudgment can wreck hours or days of work. Pooler recalls the time her team was called upon to paint out the vestiges of stunt gear from a 3,000-frame paratrooping sequence from a big-budget adventure movie.

Digital Movie Stars

NAME	LOCATION	SPECIALTIES	RECENT FILM PROJECTS
Cinesite	Los Angeles, CA	Digital mastering, visual effects, film scanning and recording, restoration	<i>O Brother, Where Art Thou?</i> , <i>Band of Brothers</i> , <i>Traffic</i> , <i>Planet of the Apes</i> , <i>Pleasantville</i>
Efilm	Hollywood, CA	High-resolution scanning from film to digital, laser recording from digital to film	<i>From the Earth to the Moon</i> , <i>Batman and Robin</i> , <i>Contact</i> , <i>Titanic</i>
Sony Pictures Imageworks	Culver City, CA	Scanning, color timing, modeling, character animation	<i>Spider-Man</i> , <i>Cast Away</i> , <i>What Lies Beneath</i> , <i>Stuart Little 2</i> , <i>Charlie's Angels</i>
Industrial Light and Magic	San Rafael, CA	Digital image acquisition, digital editing, visual effects	<i>Star Wars: Episode II—Attack of the Clones</i> , <i>Star Wars: Episode I—The Phantom Menace</i> , <i>Pearl Harbor</i>
LaserPacific Media	Hollywood, CA	High-definition postproduction, conversion of studio films to DVD	<i>Austin Powers: The Spy Who Shagged Me</i> , <i>Lost in Space</i> , <i>Wag the Dog</i> , <i>Magnolia</i>
Pixar	Emeryville, CA	RenderMan character-rendering software, feature-film animation	<i>Toy Story</i> , <i>Toy Story 2</i> , <i>Monsters, Inc.</i> , <i>Pearl Harbor</i> , <i>The Perfect Storm</i>
Rhythm and Hues	Los Angeles, CA	Character animation, visual effects	<i>Harry Potter and the Sorcerer's Stone</i> , <i>Men in Black II</i> , <i>The Sum of All Fears</i> , <i>Hollow Man</i> , <i>Babe</i>



Turning back time: Cinesite's Steve Wright restores flawed frames for Universal Studios' rerelease of *To Kill a Mockingbird*.

"Six of us divided the work. The first person saw a line of tiny black spots in the image and painted them out of the frame. The next person took a look and said, 'You erased all the parachutes!'"

MIXED MEDIA

The inadvertent erasure of real-world objects is only one of the occupational hazards awaiting moviemakers as digital technology continues to spread.

"Increasing technology always yields increasing complexity," says Daniel Rosen, Cinesite's chief technology officer. "If you're in a film theater and there's no image, your eyeballs will tell you what's wrong—a lamp burned out, or the film broke. If you're in a digital theater, what happened? Was the satellite down? Or the server? Or is there an encryption problem?"

A former TRW engineer, Rosen is Cinesite's resident technical visionary and voice of realism—equally alive to the virtues of digital technology and to its shortcomings. On the plus side, he

says, is the incredible flexibility producers will gain from having digital negatives of their films, which they can feed into a multitude of formats, be they theater prints, DVDs or TV broadcasts.

On the other hand, Rosen doubts that artists or audiences will soon want to give up the unique sensory qualities of film. "If we look decades ahead, people will come to realize that digital [photography] is another way of doing things, but film will give you a different organic look," he says. "It's like oil paint and acrylic. Digital has a different texture."

And just as acrylics, watercolors and other media haven't replaced oils, digital movies may never fully replace film. More likely, the two media will coexist, with digital's practical advantages and differing qualities widening directors' and cinematographers' artistic and logistical options as the technology advances. Think of it this way: if Sony Pictures ever develops a *Cast Away 2*, and the producers discover that a digital Tom Hanks can shed 25 kilograms instantly, rather than dieting for a year, then the island may not be the only thing that's virtual. **TR**