PANDORA'S DIGITAL BOX

Films, Files, and the Future of Movies

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Pandora's Digital Box: Films, Files, and the Future of Movies

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For Douglas Gomery

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Introduction

Changeover

It was the biggest upheaval in film exhibition since synchronized sound. Between 2010 and 2012, the world's film industries forever changed the way movies were shown.

For decades, a simple routine was followed. A film print emerged from a photographic laboratory and was coiled onto 35mm reels. Jammed into squat, hexagonal shipping cases, the reels were sent

to a theatre. There a projectionist inspected the print and prepared it for showing.

Until the 1970s, projection was reel to reel. The film was transferred from shipping reels to sturdier show reels. These were mounted on two projectors side by side. The projectors ran the film, at a spectacular ninety feet per minute. Each reel lasted fifteen to eighteen minutes, so there would be several changeovers per film. The upcoming changeover was signaled by a light, a bell, or a buzzer, along with punch-holes in the upper right of the onscreen image. When the warning came, the projectionist flipped a switch and the changeover was made. While the new reel was running, the projectionist threaded up the one to come. At the end of the booking, the film was wound back onto the battered shipping reels and made its way to the next venue.

This system was started in the 1910s and modified for sound cinema in the late 1920s. It made little economic sense in the 1970s. Now films opened simultaneously on thousands of prints, and most copies would never be screened after their initial run. In the multiplex era, prints had a life of only a couple of months. Moreover, manual changeover required trained projectionists to stay by each machine. The new multiplexes would have needed several expensive, unionized projectionists. Instead, platter projection came into its own.

In that method, the projectionist inspected the print, spliced the reels together, and wound the whole couple of miles of film onto a large aluminum disc. During the screening it would run continuously, from feed platter to take-up platter. When the film was fin-

ished, at the flip of a switch it would rewind back onto the feed platter at whiplash speed. After the movie's run was over, the print would be broken down into shipping reels and sent to another venue or to a depot for storage or destruction. With the platter system, many screens could be handled by one or two projectionists, or even teenage staff.

Platter projection was rougher on a print than reel-to-reel, and aficionados resented its degree of automation. Yet it retained some of the ramshackle, Steampunk flavor of the traditional method. Watching any projector in action, you saw metal gears and sprockets and drive shafts, illumination from a searingly bright lamp, and a ribbon bearing little pictures snaking its way around rollers and through a chattering aperture. Movie cameras and projectors, not-so-distant kin of the sewing machine and the machine gun, emerged from an age ruled by mechanics, optics, and chemistry. Cinema was one of the last remaining nineteenth-century machines.

But ours is the age of plastic, electronics, and keystrokes. Film on film was an anachronism. Sooner or later it would be transformed into ones and zeros.

The film is no longer a "film." A movie now usually comes to a theatre not on reels but on a matte-finish hard drive the size of a big paperback. The drive houses a digital version of the movie, along with alternative soundtracks in various languages and all manner of copy-guarding encryption. Instead of lacing a print through rollers and sprockets, the operator inserts the drive into a server that "ingests" the "content." (By now a movie has become *content*, an undifferentiated item to be fed into a database.) The

server accesses the files only after a key, a long string of numbers and letters unique to that server-projector combination, authorizes the transfer.

Once ingested, the movie appears on a monitor as an item in a playlist. Through drag-and-drop, the operator or the manager composes the whole program, from advertisements and trailers to the entire feature. When the projector recognizes the server and identifies the film as something certified to play, it runs it automatically. The projector—"just a big computer with a lightbulb inside," as one engineer described it—is noiseless, except for the air blasting in to cool the lamp. When the film has finished its run, the hard drive is sent back to the distributor for wiping and re-use.

Watching a film projector, you saw a busy, chattering machine, at once lumbering and delicate. Watching a digital projector you see nothing. Films have become files.

Historically, most major film technology has been introduced in the production sector and resisted in the exhibition sector. Exhibitors have been right to be conservative. Any tinkering with their business, especially if it involves massive conversion of equipment and auditoriums, can be costly. If the technology doesn't catch on, as 3D didn't in the 1950s, millions of dollars can be wasted.

Shooting on digital media posed no threat to theatres as long the finished films were converted to 35mm prints for screening. But distribution has long been the most powerful and profitable sector of the film industry. Today's major film companies—Warners, Paramount, Sony et al.—dominate the market through distri-

bution. So when the Majors established the Digital Cinema Initiatives standards, exhibitors had to adjust.

Synchronized sound reproduction took about five years to transform most national cinemas, but the digital switchover has come more slowly. In December 2000 the world had about 164,000 screens. Only thirty of them were digital. Five years later 848 were. At the end of 2010, however, 36,103 screens were digital—about thirty percent of the total. In North America, the jump was dramatic, from about 330 digital screens at the end of 2005 to over 16,000 at the end of 2010.

2011 iced the cake. In the United Kingdom, eighty percent of titles released that year were on digital formats. At the annual Cannes Film Festival there were a great many digital screenings, even of films shot in 35mm. In Belgium the two major theatre chains, Kinepolis and UGC, went wholly digital. In Norway all 420 commercial screens were converted, partly because the government funded the change.

In America, the word went forth from John Fithian, the plain-spoken President of the National Association of Theatre Owners. He said in March of 2011:

> Based on our assessment of the roll-out schedule and our conversations with our distribution partners, I believe that film prints could be unavailable as early as the end of 2013. Simply put, if you don't make the decision to get on the digital train soon, you will be making the decision to get out of the business.

Twentieth Century Fox took the lead in declaring that at the end of 2012 it would circulate no more film prints, including titles handled by its art-house subsidiary Searchlight.

Exhibitors reacted fast. In my hometown of Madison, Wisconsin, the dominant chain went digital just before Labor Day 2011 and, with ironic timing, fired its projectionists. Hundreds of U.S. theatres junked nearly all their 35mm equipment, saving only a projector or two for the occasional film print. By the end of the year, about 26,000 of America's screens were digital—two-thirds of the total.

We have passed the tipping point. By early 2012, over half of the 137,000 screens in the world had converted. The hundreds of new multiplexes opening in China, at the rate of eight screens per day, do not contain reels, splicers, or a scrap of photographic film. "Some time in 2013," says a spokesman for the National Association of Theatre Owners, "all the [U.S.] screens will be digital." By 2015, predicts *IHS Screen Digest*, 35mm projection will be defunct in commercial cinemas.

As someone who studies film history, I've long wished to travel back to witness major changes in the medium I love. I wasn't alive when exhibitors migrated from storefronts to dedicated venues in the 1910s, or when they wired silent-movie venues for talkies. I was alive, but not especially sentient, when theatres converted to widescreen in the early 1950s. Deprived of a time machine, I've longed for on-the-ground reports of what these moments were like. From our vantage point we can study these developments at the macro-level, but witnesses at the moment left us few records of the

pulse of change. Working at a distance, we gain perspective and can see connections not apparent to participants; but our distance denies us access to the texture and oscillations of the process as it moved from day to day, month to month.

My goal in this little book is to have my cake and eat it too. I hope that my experience studying film history helps me spot some broad-scale trends at work in today's shift from film prints to digital files. What forces brought it about? What does the change tell us about the business of making and showing movies? What are the effects, both immediate and long-term, of the conversion? How does it change our experience of movies and moviegoing? Full measure of the changeover will have to await a more judicious and detached view, but I want to offer some first quick sketches of how it happened, with some hunches about why.

Because I'm working from early, sometimes contradictory information, it's likely that I'll make some errors of fact, inference, and judgment. Future historians will need to add to and subtract from my account. In the meantime, I hope to capture a sense of immediacy. The process of digital conversion has wriggled and twisted in my grasp, so this book is as much an account of a wrestling match as a record of research. I'd be happy to win two falls out of three.

The most tempting parallel is with the changeover to sound cinema during the 1930s, a wholesale revamping of movie theatres around the world. The comparison is fair up to a point. But the digital revolution in our theatres has been a muffled one. Talkies were markedly, triumphantly different from the silent cinema that they replaced. Everybody noticed that. Today, most moviegoers wouldn't

be aware that they were no longer seeing film prints in their local multiplex. Few would care.

So we have to peer behind the scenes. If we do, we find striking changes. During a severe economic depression, U.S. companies invested a sum estimated at over two billion dollars in digital projection equipment. In the space of a few years, tens of thousands of film projectors, many brand-new, were thrown out as scrap. Thousands of projectionists were fired or reassigned to maintenance tasks. Longer-range, we may expect thousands of screens to close because owners can't afford the cost of conversion. The digital conversion has strengthened Hollywood's major companies and the biggest theatre chains, but it has threatened independent distributors and small theatres. Indeed, every area of film culture, from multiplex and art-houses to film festivals and archives, is being profoundly altered.

The change isn't simply a matter of new technology, or hardware turning into software. It isn't simply a matter of fancy gear or even the look and sound of images. It involves social processes, the way institutions like filmmaking and film exhibition work. Technology affects relations of power, along with the choices that moviemakers and filmgoers are offered. As films become files, cinema changes in subtle, far-reaching ways. People may not have noticed the difference between a 35mm image and a digital one, but as moviegoing becomes different, so does our sense of what films are, and have been.

This little book is a first attempt to chart how all that has happened, and to suggest what may lie ahead.

Pandora's Digital Box: Films, Files, and the Future of Movies grew out of a series of entries on the blog site I publish with Kristin Thompson, *Observations on film art*. I began studying the transition in September of 2011 and posted my first entry in December. The series was initially planned for only three entries, but as I learned more, the thing grew to eight installments, finishing in late March 2012.

Somewhere along about the fourth part I realized that this could become a mini-book. Yet I haven't reprinted any entry without alteration. I've taken the opportunity to rewrite and reorganize the material while adding information I couldn't squeeze into the series. I've tried at the same time to make these chapters more compact and less digressive than the blogs. The original entries remain available online.

One advantage of Web publication is timeliness. It took only eight weeks from completion of the series to the text now hovering on your screen. Even if I could find a publisher to produce a book this tiny and ephemeral, it couldn't be brought out so quickly. So much the better for authors, and readers.

I owe a great many people thanks for guidance and information. Theatre operators in and near my hometown have been eager to answer my stream of questions. Thanks, then, to Merijoy Enrizzi-Ray and Hal Theisen of Sundance Cinema, Madison, Wisconsin; Rick Reavey and Adam Hasz of AMC Star Fitchburg 18, Fitchburg, Wisconsin; and Robert "Duke" Goetz of Goetz Theatres, Monroe, Wisconsin. Not so near but still of great help was Michelle Haugerud of the JEM Theatre in Harmony, Minnesota.

For technical information, I turned—constantly—to Erik Gunneson, Jim Healy, and Stew Fyfe of the Communication Arts Department of the University of Wisconsin–Madison and Tom Yoshikami of the Marquee Theatre at our university. Also helpful was the virtuoso James Bond, who installed new Kinotons for our Cinematheque; Bill Kinder of Pixar; Brad Miller of Film-Tech, Plano, Texas; and Chapin Cutler of Boston Light & Sound, who patiently explained many things digital to me. Whatever errors crop up in my account of technical factors are wholly my own.

David Hancock of *IHS Screen Digest* shared industry statistical information with me with cheerful alacrity. Less formal backstory on the Hollywood industry came from David Poland, paterfamilias of Movie City News, and Jim Emerson, one of the best reasons to become a Netizen.

On the ins and outs of art-house distribution, I'm grateful to James Schamus, Jeff Roth, and Jack Foley of Focus Features. Hardworking proselytizers for the specialty-cinema cause include Russ Collins of the Michigan Theatre and the Art House Convergence; Lisa Dombrowski of Wesleyan University; Juliet Goodfriend of the Bryn Mawr Film Center; Sanford Hess of the Art Cinema, Urbana, Illinois; Jenn Jennings, who is making a film about the digital transition; Jan Klingelhofer of the Art House Convergence; and Mike Maggiore and Bruce Goldstein of the Film Forum, New York. A special thank you to the Art House Convergence group for welcoming me to their annual confab and letting me join their informative listserv.

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Closest to home, Jim Cortada of IBM and the Irvington Way Institute was of daily help. The design of this book is modeled on his trim monograph, *Information and the Modern Corporation* (Cambridge, MA: MIT Press, 2011), and he scrutinized the entire manuscript with an eye to firming up my grip on IT. Jeff Smith's reading of a draft, along with his many conversations with me, have helped me clarify my ideas. Meg Hamel has provided her customary expert editing and design for another of my Web experiments. Kristin Thompson was as unfailing as ever, ripping apart dumb sentences with precision and solicitude.

Douglas Gomery's work on the American film industry has shaped my thinking for years, going back to our teaching together at the University of Wisconsin in 1973. He was the first person I met who tried to analyze American moviegoing systematically. I was proud to help publish his pioneering study *Shared Pleasures: A History of Movie Presentation in the United States* in our series at the University of Wisconsin Press twenty years ago, and he has remained a loyal friend. This book is dedicated to him.

Acronyms for a New Age

Here are the most important acronyms and terms of art used in the book.

1.3K: Designation of High Definition projected digital image with 1280 vertical lines and 720 horizontal lines. Also known as 720p, with the "p" indicating progressive scan. The aspect ratio of the image is 16:9.

2K: Designation of projected digital image with approximately two thousand vertical lines. The approximation is necessary because of the variations in aspect ratio. For example, a 2.4, or anamorphic, aspect ratio will have 2048 x 858 pixels, while a 1.85 aspect ratio will have 1998 x 1080 pixels.

4K: Designation of projected digital image with approximately four thousand vertical lines. The approximation is necessary because of the variations in aspect ratio. For example, a 2.4, or anamorphic, aspect ratio, will have 4096 x 1716 pixels, while a 1.85 aspect ratio will contain 3996 x 2110 pixels.

AMC: American Multi-Cinemas; in 2012, the largest exhibition chain in the United States.

ASC: American Society of Cinematographers, professional association of major directors of photography.

Big Three: The three major circuits of U.S. film theatres: American Multi-Cinemas, Cinemark, and Regal Entertainment. As of 2012 these chains control over 16,000 of the approximately 39,000 U.S. screens.

DCDM: The Digital Cinema Distribution Master, a set of files created in post-production that will be converted to a Digital Cinema Package. When identified with an asterisk, the DCDM* refers to the output when the theatre's server unpacks and decompresses the DCP.

DCI: Digital Cinema Initiatives, consortium of American production and distribution companies creating the functional architecture and specifications for digital film projection.

DCIP: Digital Cinema Implementation Partners, consortium of the three major cinema circuits—AMC, Regal Entertainment Group, and Cinemark—formed to launch installation of digital equipment in their theatres.

DCP: Digital Cinema Package, the ensemble of files stored on a portable hard drive and delivered to local theatres. The files, compressed from the Digital Cinema Distribution Master, encode the film (image, sound, closed captions, etc.) and carry encryption protecting it from security breaches.

DI: Digital Intermediate, a digital version of a production's final footage. It may originate in digital production or be scanned in from photographic film. The DI is created by manipulations in

post-production. Roughly comparable to the negative in the film-based process.

DLP: Digital Light Processing, a trademark designating a method of projecting images by means of microscopic mirrors. The basis of Texas Instruments' digital cinema projectors.

DSM: Digital Source Master, the result of post-production that will create the DCDM, as well as a master version for home video or other platforms.

DVD: Digital Video Disc (aka Digital Versatile Disc), a format that typically uses MPEG-2 compression to store video on a 4.8-inch disc having a capacity of 4.7 GB in a single layer and up to 8.7 GB in a double layer.

E-Cinema: Before the 2000s, "electronic cinema" was a generic term for digital projection. After the standardization of 2K and 4K for commercial exhibition, "e-cinema" came to denote 720p, 1.3K projection, and other secondary formats.

HD: High Definition video. Formats include both digital and analog ones, commonly at resolutions of 480, 720, and 1080.

Interoperability: A set of guidelines for equipment and practices that will assure that rapidly changing technology does not render older systems obsolete too quickly. In digital cinema, interoperability has permitted early projection systems to work with current content while manufacturers make new machines compliant with more stringent specifications.

JPEG 2000: Compression standard for high-end imaging and video recording, used in medical imaging, mobile phones, and Digital Cinema.

KDM: Key Delivery Message, a file carrying the alphanumeric security key for the film. Loaded into the server for a specific projector, the KDM authorizes the film to play uniquely on that server and projector.

LCoS: Liquid Crystal on Silicon, an array of liquid crystals that reflects an image, somewhat in the manner of DLP. LCoS technology, under the trademark SXRD, is the basis of Sony's Digital Cinema system.

Majors (aka The Big Six): The six principal Hollywood production and distribution companies: Disney/Buena Vista, Twentieth Century Fox, Paramount Pictures, Warner Bros., Sony/Columbia, and Universal.

Megaplex: Theatre facility housing sixteen or more screens.

Miniplex: Theatre facility housing between two and seven screens.

MPAA: Motion Picture Association of America, the trade association and lobbying agency for the major production and distribution companies.

MPEG-1: Compression standard widely used for digital television, digital audio broadcasting, MP3 audio, and VCDs.

MPEG-2: Compression standard widely used for digital television and DVDs.

MPEG-4: Compression standard widely used for Web streaming and computer playback of films and television programs.

Multiplex: Theatre facility housing between eight and fifteen screens.

NATO: National Association of Theatre Owners, trade association of U.S. theatre proprietors and operators.

NCM: National Cine-Media, supplier of preshow advertisement and other content to theatres; owned by the Big Three.

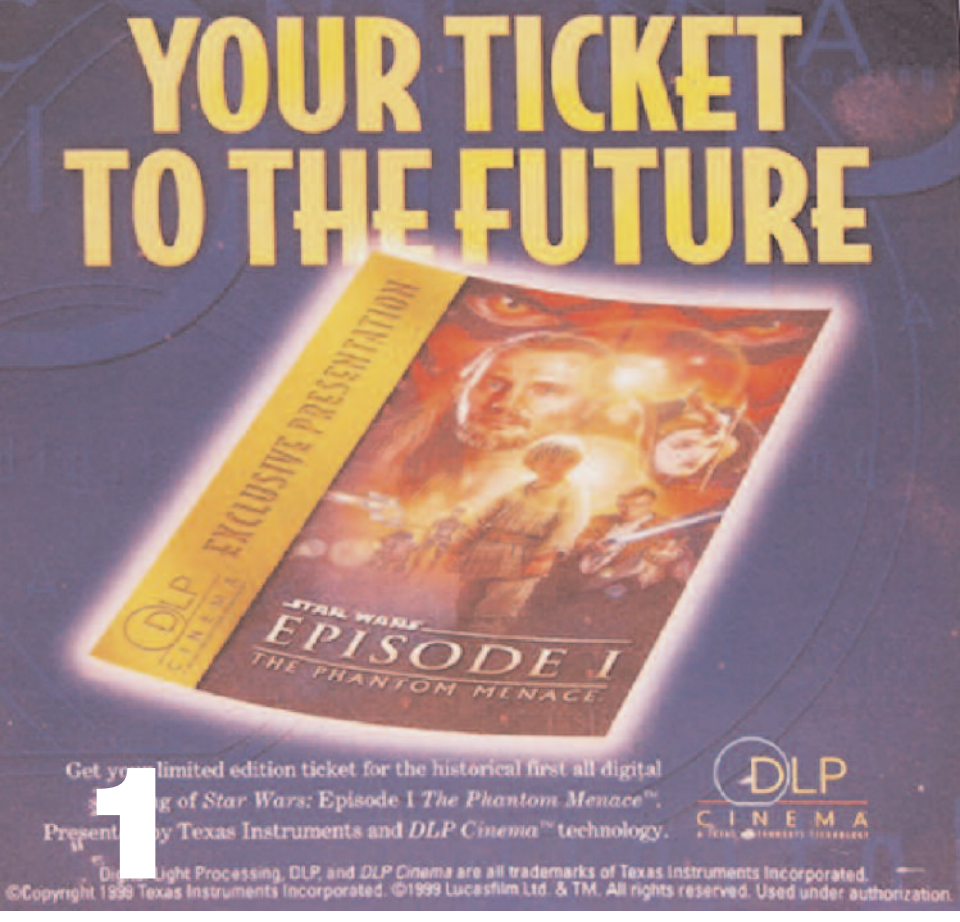
NDA: Non-Disclosure Agreement, an arrangement whereby parties to a contract consent not to divulge the contents of the contract.

SMPTE: The Society of Motion Picture and Television Engineers, a professional association of technicians working in moving-image industries.

VCD: Video Compact Disc, a format that uses MPEG-1 compression to store motion pictures on a 4.8-inch disc, with a capacity of up to 800 MB.

VOD: Video on Demand, a service that enables viewers to watch movies distributed in a digital network, such as the World Wide Web.

VPF: Virtual Print Fee, a fee paid by distributors to a third-party integrator who has supplied the digital projection system. Typically the fee is applied for each film booked for a stipulated period.



1 The Last Redoubt

> This is the only major industry still using nineteenth-century technology.
>
> George Lucas

Of the many stories George Lucas has told, one explains why he decided to make the trilogy leading up to *Star Wars: Episode IV* (1977). His company Industrial Light and Magic had managed to give Steven Spielberg astonishingly convincing dinosaurs for *Jurassic Park* (1993). At that point, Lucas understood that three more installments of his Jedi saga could be realized.

There's no reason to doubt this story. But discovery favors the prepared mind, and Lucas was already tuned to a particular wavelength. Surely he was primed to notice how digital technology could replace the miniatures and puppets that he had relied upon for his original blockbuster. He had begun to wonder whether digital technology could enhance the photochemical medium of movies.

For *Episode IV* he had embraced early computer-controlled effects and Dolby sound processing. He had helped develop the "nonlinear" editing equipment that was coming into wider use. He, who started out as an animator, had nurtured Pixar, the studio that would carry digital animation into the mainstream. He had created a theatre certification program, THX, that assured patrons of the finest sound—digital, of course.

Lucas asked Sony to design a prototype HD camera for *Star Wars: Episode I—The Phantom Menace* (1999), but it wasn't ready in time. Over two thousand shots in the film were manipulated by computer, leading producer Rick McCallum to remark that "it was ludicrous for us to work in an analog medium." Six of the Sony cameras would be on set for day one of *Star Wars: Episode II—Attack of the Clones* (2002). It and the final film of the trilogy, *Revenge of the Sith* (2005), would use that equipment.

But distribution and exhibition remained stubbornly analog. Lucas began to think about having his trilogy screened on High Definition video. He arranged for two competing HD systems to show *The Phantom Menace* at four theatres in Burbank and Chatsworth, California, and in Paramus and Secaucus, New Jersey. That week in June 1999 was, the story goes, the beginning of digital film projection—"a revolution in feature film exhibition," as *American Cinematographer* dubbed it.

Revolutions make good beginnings for sagas, but they aren't the whole story. To start the story of digital projection with the screenings of *The Phantom Menace* is to start *in medias res*. Part of the story transpired before 1999, and in some far-flung places.

The digits strike back

Cinema was the last medium in popular culture to go fully digital. By 2000, most entertainment industries had let computers make their work easier and more efficient. Media companies had discovered that software could go beyond accounting, tracking inventory, and other back-office operations. It could change the production, distribution, and consumption of their products.

During the 1980s and 1990s, writers grew accustomed to word-processing programs, and book and magazine publishers had switched over to computerized typography, layout, and printing. Traditional channels of hard-copy distribution were complemented by Web sales via publishers' own sites or the increasingly popular marketer Amazon, opened for business in 1995. Reference books appeared on CD-ROMs and online, although e-book versions of

mass-market fiction and nonfiction wouldn't triumph until the 2010s. The music industry found that songs, composed and scored on a computer, could be processed and digitized for reproduction too. The success of the CD format after 1983 drew consumers away from analog systems.

Photography moved away from analog image-making at the same period. Kodak was an early pioneer of digital still cameras, though ironically it would become the biggest victim when the format won the consumer market. As for television, shows were increasingly shot and edited on digital media and delivered on satellite systems. HD broadcasts began in 1998. The development of video games owed even more to digital technology. PC-based games migrated from cartridges to CD-ROMs and eventually dedicated consoles. Increasing computer memory and speed, along with more realistic graphics, made games a major entertainment industry. By the 1990s, there were online versions of games like *Doom*, announcing the digital delivery of this form of popular culture as well.

Computers entered cinema more slowly, working their way into different points in the creative process. Special effects were among the first areas affected, as simple programs were used to coordinate the movements of miniatures and the camera. Motion control, which allowed exact repetition of camera and model moves, had been pioneered in Stanley Kubrick's *2001: A Space Odyssey* (1968) and further developed by Lucas in *A New Hope*. Somewhat later, filmmakers discovered that they could replace photographic effects like matte shots with digital ones. Shooting action against a green-

screen, they could later insert any background they chose, filmed or digitally painted, thanks to software. The "virtual backlot," again strongly influenced by Lucas' efforts, became a fixture of big-budget films like *The Fifth Element* (1997) and *The Matrix* (1999).

Sound was another early area of change. Digital audiotape became the engineering standard in the 1980s, and MIDI synthesizers allowed music and effects to be altered or created from scratch. Soon sound designers were using Pro Tools and other software programs to create dense, complex mixes. These resources became available to amateurs and low-budget filmmakers.

Over the same years, film editing became nonlinear and random-access, again partly through the efforts of Lucas. Digital editing had already made headway in television production. Lucas' EditDroid, put on the market in 1984, didn't have many takers, but after it was sold and repackaged as Avid, it and a rival system, Lightworks, convinced editors of theatrical films to give up their splicers and 35mm flatbed viewers. By the turn of the century, most major and independent releases were edited on computer. The trend expanded even more after 1999, when Apple introduced Final Cut Pro, a cheap and friendly program that let filmmakers edit on a laptop.

More apparent to audiences was the emerging area of Computer Generated Imagery, which created new resources for special effects. Once more Lucas was in the forefront. His Industrial Light and Magic became one of the first specialists in CGI. The division of Lucasfilm that would become Pixar developed RenderMan, put on sale in 1989. This program allowed filmmakers to give animated creatures realistic surface texture and illumination. CGI progressed

rapidly with *Terminator 2: Judgment Day* (1991), *Jurassic Park* (1993), and other eye-catching films. For *The Phantom Menace*, Lucasfilm created a digital "synthespian," the notorious Jar-Jar Binks.

Just before the release of *The Phantom Menace*, another breakthrough was made. The massive computing power available in the early 1990s made it possible to scan a 35mm negative to digital files for further manipulation. At first the process was slow, taking many seconds per frame, but Arri and other companies devised more powerful scanners. Once a film had become a file, its imagery could be manipulated in the manner of color grading of photochemical footage. The first film to use this Digital Intermediate process was *Pleasantville* (1998). In this and later productions, filmmakers could target precise areas of the shot to be changed, an option not available in analog color grading.

By 1999, postproduction was on its way to a completely digital workflow, incorporating special effects, sound, editing, and DI reworking of the footage. Preproduction had also been digitized, with screenplay programs used to format scripts and animation permitting previsualization of sequences or entire films. Lucas eagerly embraced "pre-vis," planning out the entirety of *The Phantom Menace* in his proprietary program.

Only three areas of creative work remained stubbornly analog: shooting the film, distributing it, and showing it.

Fixing and unfixing the image

> I don't think I'd ever go back to analog. I haven't used an editing machine with film on sprocket holes for almost eight years. I hardly even

> know how to hold a piece of film any more—I don't think I could do it. It's just too much work: It's too cumbersome, too slow, and you can't manipulate it enough. It would be like going back and scratching things on rocks.
>
> George Lucas, 1997

Could digital ever conquer production? Its first beachhead was cartoons. With a series of shorts capped by the feature-length *Toy Story* (1995), the former Lucas company Pixar showed that CGI could replace traditional cel animation. Other studios set up digital cartoon units, and as was happening in other media, digital tools triumphed over their analog counterparts. Even Disney shifted to computer animation.

But cartoons were a special case. What about live-action filming? Filmmakers ridiculed the idea that the video imagery available in the 1980s and 1990s could replace 35mm film. For one thing, video formats proliferated too quickly, coming in and out of favor. Good old 35mm had been a stable medium for a hundred years.

More important, film photography had a greater dynamic range. It yielded a wider array of colors and shades of gray. Digital imagery, good at peeling back layers of darkness, tended to scorch and blow out highlights. A film shot provided a gentler transition between light and dark, saturated hues and pastels. For faces, however, cinematographers worried that HD video was *too* sensitive, rendering every pore and freckle with stark clarity. The inherent softness of film, aided by lighting and filters, wouldn't show such imperfections. And 35mm film didn't provide all those phantom contours around objects ("aliasing"), or the strange artifacts when

fast, lateral movement seemed to break into fluttering chunks of pixels ("motion smear"). Digital cinematography might be okay for television, with its undemanding 525 resolution lines, and for rarefied film festivals, but not for a big theatre screen.

Video capture of the period was unimpressive by 35mm standards. *The Celebration* (*Festen,* 1998), shot on amateur DV, attracted attention more as an advertisement for the Dogme school than as a signpost for what would come. *Chuck and Buck* (2000), *The Anniversary Party* (2001), *Tape* (2001), and other low-budget releases, however strong their dramatic value, made an indie virtue of their down-market look.

It took ten years for the resistance to digital cinematography to subside. The Sony camera that Lucas had ordered for *Attack of the Clones* was used on the French production *Vidocq* (2001), Aleksandr Sokurov's *Russian Ark* (2002), and Robert Rodriguez's *Spy Kids 2: Island of Lost Dreams* (2002) and *Once upon a Time in Mexico* (2003). Moore's Law, the claim that computing power would double approximately every eighteen months, proved valid for the moving-image business. Company after company, with names like Thomson Viper and Red, provided ever-expanding capture and storage options. The Dalsa Origin II, for instance, had a resolution of 4K and a range of thirteen exposure stops. Older companies moved into the market, with Panavision's Genesis, Sony's CineAlta, and the Arri Alexa eventually dominating Hollywood production.

The manufacturers' shift to digital had support among prestigious directors, including Michael Mann, David Fincher, and Steven Soderbergh. "I've abandoned film forever," Rodriguez fa-

mously said. "It's like trying to go back to vinyl after you've got recordable DVD."

Perhaps more significant was the admission by esteemed cinematographer Roger Deakins at the close of 2011 that he had found the game-changer. "This moment has been coming for a long time, really, but with the Alexa I believe digital has finally surpassed film in terms of quality.… I love film, sure, but this camera has brought us to a point where digital is simply better." For craftsmen like Deakins, the advantages lay in light sensitivity, resolution, clarity, textures—qualities that film had always captured but that were now improved.

For Lucas, though, shooting digitally was a whole new kind of thing. It enabled him to generate raw material he could remake in later stages of production. He liked to compare digital image-making to painting, a practice that yielded total control of everything in the frame.

> Now you can work *within* the image. The image is no longer fixed on the film. Obviously the process of visual effects—certainly from the beginning of ILM—was to "unfix" those images.

A performer could be snipped out of one shot and pasted into another. When an actor blinked at the wrong time, Lucas explained, he would simply erase it. His editor said of *The Phantom Menace*:

> There is not one shot in this whole movie that we haven't done something to. We could totally redirect the picture in the cutting room. If we didn't like the way an actor was turning his head, we would turn his head for him. I'd grab an eyeball from somewhere else, get the art

> department upstairs to clean up the edges, give us a new background…then we'd sent it off to ILM.

Lucas turned live-action cinema into a species of animation. He defended this development on the ground that movies, or at least his kind of movies, are one hundred percent artificial.

> You have news footage, you have documentary footage—which are supposedly realistic images—and then you have movies, which are completely fantasy images. There's nothing in a movie that's true or real—ever.… The people in the movie are actors playing parts. The characters are not real. The sets are not real. If you go behind that door you'll see there's no building—it's just a big flat piece of wood. Nothing is real. Not one little tiny minutia of detail is real.

Lucas was indirectly acknowledging that in the Hollywood of the 1990s, fantasy was becoming the core of cinematic appeal. The newly dominant Hollywood genres were science-fiction, horror, and comic-book adaptations, and even action pictures and romantic comedies were exploiting special effects in chase and gag sequences. Now long stretches of acted films were created in the CGI suites, and performances were tuned or transformed in post-production.

It was hard for cinematographers to argue for photochemical film if hundreds of shots were going to drop actors into virtual sets or plant them in virtual crowds or make them execute virtual stunts or turn them into animated figures themselves, as in "performance capture." Shooting everything digitally permitted a smooth blend-

ing of production and postproduction. Actors and locations became raw material for special effects.

In 2011, the manufacturers Panavision and Aaton announced they would cease production of 35mm motion picture cameras. Digital cinematography, in one form or another, had become the default in filmmaking around the world. Although many Hollywood features were still shot on 35mm, the growth of 3D and the advantages of a complete digital workflow indicated that eventually digital shooting would be the norm.

Once the film was finished, what then? In 2000 films were circulated and shown much as they had been in 1900. Physical copies were taken from some storage location to the theatres and screened on mechanical devices. Those copies were implacably analog. With all other media, and nearly all other aspects of the film industry, going digital, it seemed only a matter of time before distribution and exhibition followed.

Throughout the 1990s, articles in the trade press announced the imminent arrival of what had sometimes been called "electronic" or e-cinema and what was coming to be called "digital" or d-cinema. "Digital tech points to pix' future," headlined one *Variety* story from 1992. "Digital cinema hovers on hi-tech horizon," blared a 1995 follow-up. In 1999, five months before the premiere of *The Phantom Menace*, a meeting of theatre owners witnessed a comparison of six video screenings.

> Many of the execs saw the demonstration as a waste of time. After all, they'd been disappointed before by over-hyped systems that fell far short of traditional film in terms of image quality.… But after seeing

> six state-of-the-art systems beam images onto a 40-foot-long screen at the United Artists Denver Pavilions complex, many attendees agreed that the future is already upon us.

It wasn't quite, not even in Paramus, Secaucus, and the other sites that would play *The Phantom Menace* a few months later. But in another sense, the future had been here on display already, but elsewhere.

Repurposing on the periphery

The idea of showing video material in a commercial cinema wasn't new. "Theatre television," a method of broadcasting programs to theatrical venues, was launched after World War II but never took off. The idea recurred when digital video emerged as the new standard. In 1992 Columbia Pictures sent a compressed HD version of *Bugsy* along a fiber-optic cable from Culver City to Anaheim. The result, said an AMC executive, "left a lot to be desired." Nevertheless, many observers declared that some form of "e-cinema" would replace 35mm in a decade or two.

Throughout the 1990s, one-off tests and experiments continued. The European Community sponsored some trials of "Cinenet" and "Cybercinema," both satellite delivery schemes. The independent film *The Last Broadcast* was transmitted by satellite to American theatres in 1998. Most advocates of e-cinema didn't consider the Internet as a conduit, probably because real-time download speeds weren't sufficient, and theatres could not have hosted their own data storage. In 1995, 350 GB of storage would have been very expensive for most businesses. The immediate solution proved to be the long-

run one: uploading and shipping the film on one or more hard drives.

But some years before these experiments and the 1999 screening of *The Phantom Menace*, hundreds of thousands of people had already experienced digital cinema. In small towns and big cities outside Europe and America, exhibition was digital before digital was cool.

What had happened was what we might call "peripheral repurposing." Technology is never just a matter of hardware, or even software; it involves the power of social institutions. As we'd expect, movie exhibition and moviegoing can appropriate technology in unexpected ways.

Consider 16mm. 16mm was an amateur filmmaking format devised by Eastman Kodak in 1923, but it soon became used for nontheatrical exhibition. Since the stock was non-flammable, 16mm films could safely be screened at home, in schools, in public meeting places, and in the newsreel theatres that sprang up during the 1930s and 1940s. After the war, schools and community centers bought 16mm projectors, many from military surplus.

For the most part, 35mm was the format of choice for commercial theatres in the United States and Western Europe. But outside that area, 16mm was an adequate substitute. In 1961, Hungary reported having over 3600 16mm installations, as opposed to 803 35mm ones. In the same year, Romania claimed only 462 35mm screens and over 3100 in 16mm. Sectors of Asia relied heavily on 16mm. As late as the 1980s, India reported over 4500 16mm installations (as opposed to 8221 35mm venues) and Korea claimed

nearly 400 (significantly more than its 280 35mm screens). The proportions were surely higher in countries like Thailand and the Philippines, where commercial entertainment films were made in 16mm.

With the expansion of 16mm, a format aimed for home, school, church, and other specialty situations was repurposed for a general public. "Nontheatrical" became theatrical.

This trend intensified with the emergence of VHS tape. Like 16mm, it was a consumer format, but it was much simpler to transport, use, and copy than film. Throughout what was still called the Third World, VHS copies were exhibited in public venues, in town squares and public halls, tour buses and work sites. Asian cities boasted "video parlors" and "video clubs" and "MTV parlors," where friends could assemble in small rooms to drink, snack, flirt, and watch a movie, often a pirated Hollywood one. We can get a sense of this market by looking at the sort of warning that preceded many videos circulating in Asia:

> The copyright proprietor has licensed the film (including its soundtrack) comprised in this Video Cassette Tape for private home use only. All other rights are reserved. The definition of private home use excludes the use of this tape at locations such as clubs, coaches, hospitals, hotels, motels, oil rigs, prisons, and schools.

Which more or less announces the distribution network for Asian videos.

This peripheral repurposing of a consumer format shifted into high gear with the arrival of digital technology. The whole process

strikingly illustrates the theory of "disruptive technologies" put forth by business analyst Clayton Christensen.

Christensen posits that entrenched firms aim to sustain an existing technology, either through incremental improvements or radical innovations. As the technology improves, these sustaining firms target the upper end of the market. But elaborating a sustaining technology can make it more complicated, inconvenient, and expensive. This can leave lower-end markets behind. Christensen calls the process "overshoot": all the new bells and whistles go beyond what most users need. The big firms' overshoot often leaves space for competitors to develop technology that is cheap, convenient, and "good enough" for what might be a very big segment of purchasers at the bottom end.

For example, Eastman Kodak strove to improve its 35mm film stocks to satisfy the refined tastes of the world's top cinematographers. But for many independent filmmakers, a low-end digital format was good enough; in fact, they didn't want to struggle with all the niceties of 35mm photochemical processes. Likewise, Sony and other firms collaborated to create the DVD as an improvement on broadcast video, VHS, and laserdisc. To the professional eye, VHS was inferior to Beta tape and laserdisc, but for most consumers that tape format was good enough. Then DVD proved more convenient and of noticeably better quality. Experts knew that the DVD was still a compromise format, especially compared to 35mm, but for consumers it was good enough.

In similar fashion, an earlier, technically inferior digital medium proved good enough for consumers outside the West.

Outlaw digital

In 1993, JVC, Sony, and Philips created the Video Compact Disc. The VCD was 4.8 inches across, and could be played on computers or dedicated players. Visually, the results were pretty feeble. Since the VCD was a CD-ROM, it could carry only about sixty minutes of digitized video, using MPEG-1 compression. A film running over two hours wouldn't fit on two discs, so a third would be necessary (or the film would have to be cut down, as it often was).

Improvements were made over the years, but at a resolution of 352 x 240 pixels, the picture quality was hardly better than VHS tape. In a way, the image was more annoying than VHS because it tended to go very blocky and jerky. Some VCDs were letterboxed, but that compromised picture quality even more, since there were fewer lines devoted to the image. From the studios' standpoint, the biggest threat was that a VCD could easily be copied, either to disc or to videotape.

Clearly, the VCD had no future in developed markets. In a gesture that anticipated the switch from 1.3K to 2K digital cinema, the Hollywood majors decided to set a higher quality standard for movies on optical discs. The companies laid down demands as to length (135 minutes per side), picture quality (better than laserdisc), compatability with superior audio systems, and content protection. As usual, two strong rivals emerged, but they were reconciled. Patents were pooled, and after more wrangling about copy protection the DVD as we know it made its debut at the end of 1997. The format took off in 1999, aided in no small measure by the DVD release of *The Matrix*.

The DVD was an overshoot that encouraged the spread of the VCD. While preparing the DVD and its MPEG-2 compression protocol, Sony and its co-developers licensed the inferior format to Asian companies. It was clear that the Chinese market, massive though it was, couldn't afford DVD players and discs. In 2000, China's per capita income was about $1500; a cheap DVD player cost about $200. So who could care about the Chinese market?

From the Chinese point of view, however, the VCD was a huge improvement on tape. The disc was cheaper, more portable, and easier to use. And it was the answer to a film pirate's prayers. VHS bootlegs degraded with each generation, but digital video enabled every copy to be identical to the source disc. Any pressing plant that manufactured music CDs could pump out VCDs en masse.

With Mainland China's economy growing rapidly, the market for VCDs exploded. Hundreds of companies sprang up to manufacture discs and players. It was easy for Chinese electronics manufacturers to convert audio CD players into VCD players, thereby undercutting the imported models. By 2000, a China-made VCD player cost $30 and was found in about a third of urban households. Over five hundred companies were producing VCDs. Even though Western companies licensed legitimate releases to the format, it came to epitomize low-end, Asia-centered piracy.

Probably Western companies couldn't have satisfied the regional market anyhow; local manufacturers, distributors, and retail outlets were needed to make the sales happen. So it wasn't simple neglect that made VCD a de facto regional standard. Nonetheless, the VCD became a disruptive technology. For Asian consumers, laserdiscs

were too expensive to buy, VHS was comparatively inconvenient, and digital discs and players suddenly became much cheaper. With so many movies, mostly illegal, available on the format, consumers' choice was simple.

VCDs slipped easily into the tradition of public screening of films on a nontheatrical format. Of the millions of Chinese players sold, many were installed in what *Variety* called "illegal video projection rooms that had screened pirated videos and movies not previously shown in China." By 1994 there were more than 150,000 public video venues showing tape, laserdisc, and VCDs in the Mainland. The following year, piracy was reckoned at a stunning 100 percent of the Chinese market.

VCD was good enough for public exhibition elsewhere—not only Taiwan, the Philippines, Malaysia, and Viet Nam, but in India and Latin America too. In cities and towns, entrepreneurs set up "electronic cinemas"—that is, video parlors or auditoriums screening discs, usually pirated, to paying audiences. A 1999 report notes:

> Electronic cinema is nothing new in emerging countries with dilapidated or nonexistent conventional film projection cinema infrastructure. Small-scale mobile electronic cinemas have set up in small towns for years.… Cinetransfer International, for example, offered rural areas in Mexico electronically screened *Mighty Joe Young, A Bug's Life, The Water Boy*, and other films over the years.

Once again, the nontheatrical became theatrical, this time aided by digital technology.

By the time the DVD arrived, the VCD had established its grip. The development of affordable DVD players in China somewhat

cut the interest in VCD, but today new releases still come out on the junior format. In Hong Kong, VCDs outsell DVDs at a ratio of three to one; new titles go for about US$4 and titles older than a year or so go for US$3. VCDs rent more briskly than DVDs, at a cost of less than US$1. VCD remains common in the rest of the world as well, including India and Africa. The Nigerian film industry, known as Nollywood, is wholly a consumer-format one; there are virtually no movie theatres. Digitally-made films are sold and shown wholly on DVD or VCD. "All across Africa," says one Nigerian filmmaker, "people are watching movies. They're just watching them in video shacks with a 19-inch TV."

VCD is important historically because it was the first significant digital platform for showing movies. It illustrates as well how technology is more than the gear. Intended for home use, the VCD was absorbed into a pattern of social use that had already been laid down for videotape. An outlaw format in the West, the VCD enabled piracy on a vast scale. In the process, it provided the world's first "digital cinema" experience for mass audiences.

Shootout, phasers optional

EPISODE 1™ IS THE BEGINNING.

LAST FRIDAY, MOVIEGOERS WERE ABLE TO VIEW THE FUTURE AS THE FIRST DIGITAL PROJECTION OF A MAJOR MOTION PICTURE TOOK PLACE WITH STAR WARS: EPISODE 1 THE PHANTOM MENACE.

THIS TECHNOLOGICAL AND CREATIVE MILESTONE IS BEING PRESENTED BY LUCASFILM, CINECOMM DIGITAL CINEMA AND TEXAS INSTRUMENTS. DIGITAL PROJECTION GUARANTEES THAT EVERY NUANCE OF BRIGHTNESS, FOCUS AND COLOR CAN NOW BE CONSISTENT FOR THE ENTIRE LIFE OF THE MOVIE, FREE OF SCRATCHES AND OTHER IMPERFECTIONS. IT PROMISES THAT THE FILMMAKER'S ULTIMATE VISION CAN BE EXPERIENCED BY ALL AUDIENCES,

EVERYWHERE,

FOREVER.

THE FUTURE HAS BEGUN.

Although some big players such as Eastman Kodak got involved, by the end of the 1990s two technologies emerged as the most likely options for digital projection in the Western world. Both had applications in commercial displays, like gigantic video screens at sporting events, but they were being adapted with an eye to film theatres and home uses.

The Texas Instruments Digital Light Processor was at first a single chip about an inch square. It contained 1.3 million tiny mirrors,

each one a mere .016 millimeter wide. These mirrors flipped to different positions as many as 50,000 times each twenty-fourth of a second, creating variations in hue and brightness.

The alternative technology was the Liquid Crystal Light Valve system developed by engineers at Hughes Aircraft Corporation for military purposes. The Japanese electronics firm JVC partnered with Hughes to explore consumer uses for the technology. The LCLV system used three cathode ray tubes for different color channels, then amplified their light levels to create a projectable image.

The digital screenings of *The Phantom Menace* in 1999 served as a shootout between the two systems. The film was transferred to HD tape at 2K resolution, then compressed to 1.3K for projection. Two versions were prepared, each one optimized for the rival systems. (The more TV-like LCLV system ran at 30 frames per second, the DLP one ran at the cinema norm of 24 fps.) Then in a projection room, a Texas Instruments projector and a Hughes/JVC projector were run side by side with a 35mm rig. Technicians compared and adjusted the transfers to get them as close as possible to one another and to the film print. The digital version of *The Phantom Menace* ran to 360 GB, stored on twenty 18GB drives.

Soon after the experiments, JVC bought out the Hughes stake in the Light Valve technology and announced it would be exploiting it. But that system quickly became moribund for cinema purposes, leaving the DLP device to rule the market for a time. Texas Instruments announced that it would license its micro-mirror technology to no more than three manufacturers, and the cost was rumored to

be about $10 million for rights. Not until 2005 would Sony come forward with a competitive system.

Other films were tested later in 1999 on a few screens: *An Ideal Husband, Toy Story 2, Bicentennial Man*, and Disney's animated *Tarzan*. Most used the DLP equipment, which gained early-mover advantage in the market. The rudiments of the future system—physical delivery of hard drives, a server to feed playback and projection—were in place. One release was particularly prophetic of what was to come. *Toy Story 2* was conceived as a wholly digital enterprise, from production through projection, anticipating what today would be called a digital workflow. Lucas' new trilogy left many in the industry cold, but his top-to-bottom conception of digital cinema aroused people's anticipations for what might be.

Satisfied that computerized projection had proven itself, Lucas was ready to move into cinematography. The second installment of the *Star Wars* prequel trilogy would show how much time and money would be saved without going through any analog processing. By then, surely, there would be hundreds of digital screens ready to play his product.

The 1999 and 2002 *Star Wars* prequel screenings made 1.3K resolution the tacit standard for digital projection. In America and Europe this became a bone of contention. A *Variety* article from 2002 asks the Christensen question: "How good a picture is good enough to replace film?"

> One end of the spectrum says, "Let's do it now. This is good enough," says Charles S. Swartz exec director and CEO of USC's Entertainment Technology Center, which tests digital cinema systems. "At the other

end, they're figuring out the theoretical best we can do and want to hold off."

While filmmakers in the West debated whether 1.3K was up to high-end standards, exhibitors in developing countries didn't hold off. They already had a tradition of seizing good-enough technology. Before 2004, nearly all of the world's two hundred digital screens used the 1.3K standard, and most of those were in Asia and Latin America. Feeding them were digital releases, which increased from both Hollywood companies and from distributors in other countries.

China was the most eager adopter; in 2004, it had more digital screens than the United States. In Brazil, small cinemas and chains began adopting 1.3K projection. In India, UFO Moviez and E-City Digital installed hundreds of low-resolution projection systems, often fed by satellite. Many local observers considered these HD displays worthwhile improvements on the battered prints and faded arc-lamps that were staples of most village screenings. As usual, good enough was measured in relation to what went before. Ironically, the screens Lucas wanted for his third installment wound up mostly in minor markets.

Despite today's movement toward 2K projection, the good-enough strategy persists in some countries. Many domestically made Chinese films are released in 1.3K versions, and some are even shot in .8K (1024 x 768 resolution). These can't be encrypted, and so pirates are making the most of the situation. And India's major supplier of digital projection, UFO, works with the MPEG-

4 codec used in Blu-ray. This has caused complaints from viewers, but the company's managing director claims, "In a market with ticket prices averaging between Rs 10-50 [US$.20-$1.00], there is no way DCI standards will take off in India." For some time, 1.3 K resolution is likely to remain a parallel system to the Western theatrical standard. The popularity of the format grows out of a tradition that had learned to exploit the down-market prospects of a disruptive technology.

In the most enduring version of Lucas' story about himself, he played the rebel, aiming to tear down the studios that stood between filmmakers and their audience. Digital production, distribution, and exhibition would let everyone of talent into the game. Why, he asked in 2006, couldn't a young filmmaker simply take a home-made movie to the local multiplex and ask them to book it? He answered his question: "It's a matter of greed and control.… It has nothing to do with making movies or showing movies or anything. It has to do with trying to be greedy and control it."

It's hard to know if Lucas really was oblivious to the power of branding and oligopoly control that gave his and other Hollywood films overwhelming advantages in the marketplace. In any case, his knocks against the industry were in vain. At that very moment, the corporations that Lucas vilified had already turned his Edenic vision of digital cinema into a business plan. At its center, as he claimed, lay control.

2

From E-Cinema to D-Cinema

▲ Stall selling pirated VCDs and DVDs, Hong Kong

Lucas had hoped to release *Star Wars: Episode II—Attack of the Clones* on two thousand American digital screens. When it opened in 2002, it played on sixty-three. For *Episode III—Revenge of the Sith*, released in May of 2005, there were fewer than a hundred U.S. screens capable of showing it digitally. Lucas fumed.

> They deny that they're stalling, but six years is a long time to wait for this stuff to happen. They'll say, "Oh, no," but we've been shooting this way for six years, we've been projecting this way for six years, the

> equipment's all there, everything's ready to go, the quality's better than film, and they're still just arguing among themselves about nothing.

John Fithian, head of the National Organization of Theatre Owners, summed up his members' thinking: "I don't put projectors in just for *Star Wars*."

Fithian's response is characteristic of the theatres' place in the production-distribution-exhibition ecosystem of cinema. You might imagine that since digital cinema was a matter of exhibition, theatre owners would have been the ones to explore its possibilities. They might, as Lucas dreamed, have arrived at a system that was cheap and convenient for them and that leveled the playing field so that any filmmaker, big or small, could prepare a digital copy and shop it to the theatre chains for showing.

But exhibitors couldn't take the lead in such a sweeping change. They are by nature cautious; tinkering with what's working today could be ruinous. Historically, the grand technological changes haven't come from the exhibition wing. Cup holders, yes; widescreen cinema, no. Moreover, what if the new digital platform were to be rejected by the theatres' suppliers, the major distributors? Movie houses big and small would starve without the Majors' releases. It's not surprising that the momentum for digital, once Lucas and others had demonstrated its technical feasibility, came from elsewhere. Lucas may have prodded and provoked, but this innovation wasn't consummated by filmmakers. Only the distributors had the power to launch and sustain technological changeover on this scale.

Distribution: The center of power

For about a hundred years, film distributors have sought to control exhibition. The advantages are obvious. Controlling exhibition keeps competitors off screens, it yields more or less assured revenues, and it allows vast economies of scale. If you can count on 2000 to 4000 screens playing your movie, as is common for Hollywood releases today, you can budget your production accordingly.

From the 1920s through the 1940s, studio control was quite direct. The Big Five companies (Paramount, Loew's/MGM, Twentieth Century Fox, Warner Bros., and RKO) wholly or partially owned hundreds of theatres, and these served as display cases for their product. Because no studio could supply all its theatres with films, studios shared their screens with their peers and kept other companies' films out. "Here," historian Douglas Gomery writes, "was a collusive oligopoly (control by a few) that operated as an almost pure monopoly."

The studios didn't own most of America's theatres, just the most profitable ones. The thousands of independent houses and chains were subjected to studio control in more indirect ways. The studios forced the independents to rent films in batches ("block-booking"). To get prime releases, the exhibitors had to take weaker titles. Likewise, the independents had to bid for upcoming releases without being able to see them ("blind bidding").

By owning theatre chains, distributors managed to structure the market in advantageous ways. Adolph Zukor pioneered the system of runs, zones, and clearances. If people wanted to see a new release immediately, they had to pay top dollar at a first-run theatre. After

a certain interval, the clearance, the movie would play a second-run theatre in another zone at a lower price, and so on down the food chain of movie houses.

Technology was another strategy of control. The 35mm film standard wasn't proprietary, but the sound systems that the studios adopted in the late 1920s were. Of the dozens of systems, only two became standardized: Western Electric and RCA. In a process similar to what's happening today, theatres were forced to install one system or the other. The thousands of exhibitors that couldn't afford the new technology went dark.

This system worked to the Big Five's benefit until the late 1940s, when the Supreme Court declared Hollywood's vertical integration monopolistic. The studios chose the wisest way to break up, given the slump in admissions: they divested themselves of their theatres and concentrated on production and distribution. (The process of divorcement took several years in some cases, and there often remained close unofficial ties between the Majors and their former circuits.) In addition, block-booking and blind bidding were outlawed, so some market factors became more favorable to exhibitors.

The postwar studios occasionally tried to remake exhibition through new technology. CinemaScope, designed by Twentieth Century Fox, sought to become the industry standard for widescreen presentation. Although there was considerable take-up, it had competition from other systems (notably Paramount's VistaVision) and exhibitors were able to wring concessions from Fox. For example, exhibitors were reluctant to install magnetic stereo playback, and so Fox had to compromise by producing prints that could play on optical sound systems as well. Similarly, while various

70mm formats were tried, none became obligatory for exhibitors, since films released in 70mm were also released in 35mm, if only in later runs.

Of course Hollywood still had a desirable product and could charge dearly for it, so stiff contracts for revenue returns gave studios considerable power. In the 1970s, the Majors (which no longer included RKO and had expanded to include Disney, Columbia, and Universal) found another way to use market dynamics to control exhibition. To publicize *Jaws* (1975), Universal launched massive television advertising and avoided the "platforming" or exclusive engagement practice. Studio chief Lew Wasserman opted for saturation booking, releasing *Jaws* on over 400 screens simultaneously. A month later it expanded to over 600.

The growth of the blockbuster, nurtured by *Star Wars* (1977), *Superman* (1978), and other huge hits, encouraged theatre chains to build multiplexes. Exhibitors could hold over some movies for months while rotating regular releases through other screens. While the distributors could blanket screens by opening very wide, theatre owners could realize economies of scale with centralized ticketing and projection facilities.

With the arrival of cable, satellite transmission, and home video in the 1980s, studios were able to maintain tiers of price discrimination. The theatrical opening became the loss-leader, usually earning less income but establishing buzz for the ancillary market. Theatrical runs were shortened considerably, but the "windows" of video distribution became the equivalent of second- and later runs. Today, the windows are even more numerous. A movie becomes

available on Pay Per View, then VOD and/or DVD, then premium cable, and so on. The windows' lengths and sequence have changed over the years, but throughout, by carving up the market by price discrimination the studios continued govern the cycle of exhibition.

My account makes recent history too neat, with studios apparently steamrollering unprotesting exhibitors. In fact, exhibitors have responded to some pressures by dragging their feet or pushing back. Better sound systems took some years to penetrate the market. Some big theatres refused to play *Star Wars: Episode I—The Phantom Menace* because of onerous terms, including a minimum guarantee and a commitment to a lengthy run in a 'plex's biggest auditorium. More recently, studios' efforts to shorten windows and release films sooner on DVD or on Video on Demand have sparked resistance.

Studios have periodically tried to reintroduce vertical integation. When the Reagan Justice Department relaxed enforcement of anti-monopoly laws, firms made some attempts to acquire interests in theatre circuits, but these were sporadic and fairly small-scale. Only Viacom found success owning both Paramount and the National Amusements theatre chain. Today, technology is providing a more effective lever. Digital projection has furnished the most thoroughgoing opportunity for studio control over exhibition since the coming of sound, and perhaps since the days when the Majors began acquiring movie houses.

Boffins and scofflaws

While the studios pondered how to make digital projection work to their benefit, an initial impetus came from a less glamorous quarter: the Society of Motion Picture and Television Engineers.

SMPTE is an organization dedicated to setting precise engineering standards for all aspects of film and television technology. Soon after the 1999 tests of "e-cinema" with *The Phantom Menace*, *An Ideal Husband, Toy Story 2*, *Bicentennial Man*, and *Tarzan*, SMPTE established a committee to consider how standards might be written for digital projection. It sponsored field trials of different systems. SMPTE presentations during 2000 to 2002 anticipated a good deal of the structure and details of the digital standards that would emerge in a few years. From packaging and encryption to 2K resolution, the Society's early recommendations helped structure the debate that ensued.

But the perennial problem faced by SMPTE is that instead of setting standards that manufacturers and users adopt, the manufacturers and users leap ahead in a competitive rush. That leaves SMPTE to sort out the protocols and hardware that have emerged willy-nilly. 35mm motion picture film was the norm from 1894, but it was not officially standardized by the Society until 1917. From 1954 onward, CinemaScope was adopted and revised in a rough-and-ready manner under the pressures of business competition. The Society did not offer rigorous standards for the format until 1957, and it continued to play catch-up as anamorphic imaging changed. Something of the same thing happened with the digital initiative, with Texas Instruments' machines already being pur-

chased and used throughout the early 2000s, before SMPTE had begun laying down standards.

SMPTE tried to be a neutral clearing-house, but without input from end users, it could not claim any authority for its efforts. Some members were employees of companies that were pushing technological change in rival directions. No overarching power could guide the Society to pick one format or another. Michael Karagosian explained in 2002:

> One of the major reasons technology agreements have not been reached in the SMPTE DC28 Technology Committee is because broad user input, based on significant user agreement, has not been received. Without such agreement today, we have a manufacturer-driven market, where each manufacturer hopes to gain sufficient market share in an effort to claim they are a *de facto* standard.

Even though SMPTE could explore only technical matters, not implementation or business models, the Society's careful scrutiny of digital projection may have impelled the studios to try to master the situation.

An even stronger spur to action was the surge in piracy in the late 1990s and early 2000s. Redubbed VHS tapes had always been a thorn in Hollywood's side, but the arrival of consumer digital media stepped up piracy spectacularly. Most egregious were the "auditorium versions," movies shot with a video camera during a screening. Ugly in the extreme, auditorium versions were acceptable—good enough, in Clayton Christenson's sense—in peripheral markets. Better-quality copies came from prints that projectionists had smuggled out and copied on a telecine machine. And once dig-

ital technology had taken over post-production in Hollywood, someone in a post house could rip the files of a film in progress and send them anywhere for distribution.

On a file, a film could be converted to a consumer digital format and sold on VCDs in the malls and street markets of Taiwan, Hong Kong, the Philippines, and Malaysia. Because most U.S. films weren't allowed theatrical release in Mainland China, that country held the biggest market, and neighboring Hong Kong became the prime supplier. In 1998, 48 million illegal VCDs were seized in Hong Kong, a small fraction of those in circulation. Eastern European countries, along with Italy and Spain, were hotbeds of digital piracy as well.

The Motion Picture Association of America estimated that it lost hundreds of millions of dollars to video piracy. While such figures are exaggerations (many purchasers of pirated discs wouldn't have bought a movie ticket), the panic in the industry was immense. Clearly, physical prints that could be swiped or filmed off the screen invited theft.

With the arrival of the DVD in 1997, bootleggers had access to purer source material. Cracking the security encryption was literally child's play. Teenagers all over the world found online software that enabled them to rip a movie from disc and share it with others. More systematically, pirates could grab the files from a legitimate disc and make counterfeits. And ever-faster Internet download speeds made it possible to send DVD-quality rips across national boundaries. The first two *Star Wars* prequels popped up online well before theatrical release. Film executives nervously watched music

sales cratering as file-sharing sites made songs available for free online. How soon before there would be a Napster for movies?

As with the music industry, there was also the problem of displacing distribution structures. As a proprietary trade publication put it, the studios had a worry they couldn't admit outright:

> If digital projectors were in wide use with an independent middleman providing easy transmission to theaters, film producers would in theory be able to release films theatrically without studios. The ability of Hollywood's six largest studios to theatrically release films globally is unique and represents a barrier to entry to anyone thinking of crashing into the ranks of the majors.

When a third party proposed to buy and install the projectors and then charge the studios for delivering the films to theatres, one distributor replied sharply, if with some mixed metaphors: "We at Disney oppose a system in which a single, outside, parasitic entity serves as a gatekeeper, with its foot on the throat of both studios and exhibition."

Clearly, if there was to be a changeover, the majors would have to orchestrate it. Yet any collusion among them could make them vulnerable to anti-trust litigation. For a time some studios considered that Newco, a nonprofit entity they established, could lease equipment to exhibitors, but the idea was abandoned for, among other reasons, such anti-trust concerns. Instead, the majors might have the authority to agree upon a set of technical recommendations for uniform formats, tools, and practices to guide manufacturers and supply firms.

According to one source, this authority was granted by a Department of Justice waiver, but I've been unable to confirm that. In any event, Disney/Buena Vista, Twentieth Century Fox, Paramount Pictures, Sony Pictures Entertainment, Universal, and Warner Bros. banded together to form a corporation called Digital Cinema Initiatives. It began its work in March 2002.

Plug and play

The tasks facing the DCI group were threefold. First, there were too many technologies out there. Companies had floated several different compression schemes and file formats. The exhibitors worried that they were seeing a replay of the early 1990s, when they had been obliged to install playback equipment for several competing digital sound systems. "There needed to be the same kind of standards that there are for 35mm film," claimed a projector manufacturer. "You can send reels of film anywhere in the world and they can be viewed in any theater. [The studios] decided you need that kind of plug-and-play for the digital film." So the DCI would have to set a benchmark for the entire industry—if not in terms of strict standards, at least in terms of guidelines about the fundamental architecture of the system.

Secondly, performance had to be consistent. Already some systems had proven unreliable. Twentieth Century Fox, an early exponent of digital with the *Star Wars* prequels and others, was annoyed that the 1.3K format was breaking down far more often than 35mm film. Sensitive to such problems, the theater owners were happy to urge the DCI to take its time.

Finally, and most crucial, was the issue of piracy. The new system would have to be airtight. A film would have to be secured in transit and during its time in the projection booth. There would also have to be some identification of the unique copy, in order to trace any auditorium versions. Fulfilling these demands would consume a good deal of the DCI's energy.

Hollywood already had a tradition of coordinating large-scale technological changes in a careful fashion. In adjusting to the coming of sound, for example, the Academy of Motion Picture Arts and Sciences' technical branch had organized a fairly systematic set of committees, tests, and training sessions that pooled information about standards and best practices. When arc lighting on movie sets created too much noise for sound filming, the Academy arranged for the American Society of Cinematographers to conduct demonstrations showing how incandescent illumination could solve the problem. Similarly, the DVD format was created through judicious coordination of technology firms, manufacturers, the studios, and other interested parties.

Throughout history, Hollywood's major stakeholders realized that everyone would gain from a consistent technical base and work routines. This sort of central coordination also had the advantage of maintaining the distributors' oligopoly. The major studios and the biggest supply companies, like Eastman Kodak, had an inside track to the setting of standards. Independent producers and small manufacturers were shut out of the negotiations.

The DCI group followed precedent in coordinating the work of the central players—the top distribution companies, the major

technology firms, the professional associations, and the theatre owners. Consulting on the process were studio technology experts, SMPTE, the Science and Technology Council of the Academy, and the American Society of Cinematographers. Tests were conducted at the Entertainment Technology Center at the University of Southern California, a facility funded by major studios.

Installed on the top floor of the El Capitan Theatre on Hollywood Boulevard, the DCI had as its CEO Charles (Chuck) Goldwater. Although Goldwater had worked in distribution, he was principally known as an exhibitor for his stints at the top of several theatre chains. He could thus be a promising liaison with the National Organization of Theatre Owners. The delegate from the ASC was Curtis Clark, the head of its Technology Committee and a cinematographer with minor film credits but with hundreds of television commercials under his belt. Clark coordinated some elaborate tests comparing film and different digital formats.

Nice pictures, but please lock them up

The DCI had to please two constituencies. Exhibitors were concerned about costs, and they wanted their day-to-day operations to change as little as possible. They were alert for any sign that the studios sought to control their business decisions. On the other side, producers, directors, cinematographers, and actors were worried about how digital projection would look and sound.

Filmmakers had been enticed by the Digital Intermediate, but they were aware that it was one thing to see a digital copy in a multimillion dollar studio screening room and another to see it in a 'plex.

Did exhibitors, whose main focus was concessions, really care much about showing movies properly? Some on the production side believed that theatres would happily screen films on those cheap video projectors that were coming into use for preshow advertising. One slogan that circulated was "Digital cinema is not HDTV on a big screen." Fithian of NATO had to reassure filmmakers that he represented people who were more than glorified candy hawkers and who respected the artistry of film.

Moreover, many directors and cinematographers opposed digital imagery in principle. They would need to be convinced that the "film look" would be preserved, or at least, as the phrase went, that everywhere it was shown the film would look exactly as its creators wanted it to look.

A central issue for the creative community was, of course, resolution. When the DCI group began its work, all commercially available digital projectors were at the 1.3K level identified with "e-cinema." Fairly quickly, the choice boiled down to 2K (supported by Disney, Universal, and most of the other studios) versus 4K (favored by Warners and Paramount). Goldwater told international theatre owners early in 2003 that the DCI was committed to "a forward-looking overall 4K delivery system" that would be better than 35mm. But he had to retreat on that front. In fall of 2003, Texas Instruments introduced its new upgrade that permitted 2K resolution. It was clear that 4K, while desirable, was going to take some time to develop. The DCI settled on 2K as the minimum but allowed the possibility of 4K upgrades.

Other DCI guidelines signaled a concern for improving image quality. Instead of the more common video codecs in use, such as MPEG-4, the DCI group opted for the data-rich JPEG 2000, which allowed images of varying resolution to be extracted from the stream. That would permit both 2K and 4K to be projected from the same file. Likewise, in contrast to the 8-bit color depth that had been used for the early 1.3K projection platforms, the DCI specified a 12-bit one, which yielded better sensitivity and contrast. Brightness, uniformity of color and illumination, and many other dimensions of the image were scrutinized. Knowing that they had only one chance to get the fundamentals right, the DCI representatives opted for a high-end image that would satisfy filmmakers and set theatre presentation off from home video and earlier e-cinema.

As early as March 2003, some crucial recommendations were already determined, and the DCI published a list of them in November 2003. These clarified core image and sound characteristics, including the 2K/4K benchmark. The document sent signals to the manufacturers, enabling them to start redesigning projectors, servers, and other equipment. In addition, NATO seemed on board. The DCI committee announced that it hoped to continue testing, with a final report to be submitted in the spring of 2004.

What prevented that schedule from being met were two issues that didn't bear directly on image or sound quality: security and financing. The studios continued to insist on heavy encryption for the films in the digital package. Since the DCI's launch, piracy had soared. As more consumers acquired DSL Net connections, they used the faster speed to access copyrighted music and movies. One

2004 estimate was that there were a staggering 400,000 to 800,000 illegal downloads of film each day. The industry responded with a massive anti-piracy campaign that has not abated since.

Accordingly, the DCI group had to devise methods of blocking piracy, and these were very complicated. The studios demanded security that would keep thieves from accessing the files in transit or in the booth. The DCI group eventually settled on the same encryption schemes that banks used for online transactions. The film's files had to "shake hands" with an authorized server and with a projector that was certified DCI compliant and that was known to be in that particular theatre. The software also had to log all usage of the film. In addition, a way was found to trace an auditorium version to a particular venue. A unique watermark, invisible onscreen, would be picked up by a pirate's camcorder and betray the theater where the video originated.

The new security protocols stirred up NATO. In December 2003 Chuck Goldwater received a starchy letter signed by John Fithian and by the president of the European theatre owners' association. Goldwater was told that the DCI was laying down controls that would alter the exhibitors' usual business operations. The rush to encode security measures into the system had precluded asking basic questions.

> Where do the trust relationships lie? When should we rely on machines and when should we rely on people? Who should control the security equipment contained within a cinema complex? When, if ever, should the digital distribution and exhibition of a movie be prevented and the movie screen left to go dark? What content (e.g.,

movies, trailers, shorts, etc.) should be included in an inviolate set of digital files that cannot be separated? Who should control the audit data and security logs produced by the system?

These questions marked out areas of concern that would resurface years later. Goldwater replied in a noncommittal tone: "The studios recognize that more work needs to be done, and should be done. We're committed to seeking workable solutions."

Over 2004 and the first half of 2005, some primary issues of control—particularly involving the ease with which films could be moved from one auditorium to another—were settled. In fact, the studios gave relatively little ground on most security issues, and the complicated encryption arrangements that came into practice proved both complicated and inflexible.

Over the same period, the DCI was asked to make recommendations on how to fund the changeover. Early on, some suggested that the DCI could serve as a conduit for buying the new equipment, but that was rejected as inviting antitrust charges. Instead, the DCI came up with a sketch of what would become the Virtual Print Fee.

Handling security and funding concerns added about eighteen months to the DCI's work schedule. The final report was published in July of 2005. By then, Chuck Goldmark had left. He would reappear as a top-level executive at Cinedigm, a major integrator for the top projector manufacturer Christie. In September, the DCI office was closed, although the studios would provide technical experts to monitor ongoing activities.

During the years of the DCI group's work, the market cleared. The Hughes/JVC digital system withdrew, leaving the Texas Instruments' DLP system the main contender. Sony pressed forward with its proprietary 4K platform, running a demonstration in summer of 2004. The system had bugs, but its spokesman was quoted as telling people not to worry: "We're ever so much smarter than Texas Instruments." The DLP and Sony systems would remain the two major options going forward.

The DCI phase of the conversion reminds us that technology isn't just about gear; it's about power. The studios congratulated themselves on once again working together to smoothly integrate a new technology. The DCI had maintained the studios' position in the marketplace and expunged equipment that they didn't want to see there. After three and a half years and at a cost of $8.4 million, the Hollywood distributors had steered digital cinema their way.

Now the problem was to get it into over 100,000 screens around the world.

3

King of the World

James Cameron and George Lucas at CinemaCon, 2011

Every spring the National Organization of Theatre Owners holds a convention and trade show in Las Vegas. It's now called CinemaCon, but in earlier times it was known as ShoWest. The gathering assembles two to three thousand exhibitors from around the world. Directors and stars show up to publicize summer and fall releases. There are screenings, award ceremonies, display booths, and panels about everything from sound systems to popcorn pricing. The con-

vention is always an extravaganza, but in retrospect the 2005 edition might seem to have been a turning point.

It took place in March, just four months before the consortium of the Hollywood studios published the full-blown Digital Cinema Initiatives specifications. At that point, fewer than a hundred U.S. screens were digital, and none of those was up to the emerging standard, which specified a minimum of 2K resolution. Moreover, no final arrangements had been made for helping exhibitors pay for the conversion. And projector manufacturers weren't close to producing fully DCI-compliant systems.

All the more significant, then, was that very big guns were wheeled out. To ShoWest 2005 came three of the most financially successful directors in history: George Lucas, James Cameron, and Robert Zemeckis. Robert Rodriguez joined them, and Peter Jackson participated in a prerecorded video clip. Their mission: to sell digital cinema.

Lucas, whose *Star Wars: Episode III—Revenge of the Sith* would open in a couple of months, was mildly hectoring. "I'm sort of the digital penny that shows up every year to say, 'Why haven't you got these digital theatres yet?'" But for Lucas and his counterparts the overt selling point wasn't digital exhibition per se. Whatever the arguments about digital vs. photochemical quality, the exhibitors needed a rationale for switching that would actually enhance their business.

The killer app for digital screening, these directors had decided, was 3D.

Lucas claimed that he was hoping to re-release the first *Star Wars* in 3D in 2007. "I'm giving you two years," he told exhibitors pleasantly. Cameron, fresh off the January release of *Aliens of the Deep* in IMAX 3D, promised the exhibitors *Battle Angel,* telling Lucas, "You can have all my theatres when *Battle Angel* moves out." Zemeckis announced two 3D films in preparation. In a 3D film clip, Jackson said, "I'm looking forward to one day seeing Hobbits in 3D."

The directors resuscitated an explanation from the days when TV threatened the movie trade: You need something special to pull viewers off their couches. In 1953, the bonus was widescreen color images and stereo sound. In 2005, the bonus was stereoscopic projection. All tentpole pictures, Cameron claimed, would be in 3D. "We now have a way to get people to come out from behind those HD flat-screen TVs and into the theatres."

Moreover, 3D offered a way to build the business. 3D screenings would bring in new audiences who seldom went to ordinary movies. Not incidentally, the enhanced format would justify higher ticket prices. But of course 3D would necessitate moving to digital projection.

The celebrity directors eventually kept their word. Zemeckis gave the exhibitors *Beowulf* in 2007 and *A Christmas Carol* in 2009, both strong performers at the box office. Cameron's *Battle Angel* didn't materialize, but when *Avatar* did in 2009, it yielded the most revenue (in unadjusted dollars) of any film in history. In February 2012 Lucas began releasing his retrofitted 3D *Star Wars* saga. Coming up at the end of that year was Jackson's first installment of *The Hobbit* in 3D. Now, thanks to the DCI standardization and the Vir-

tual Print Fee incentives, many theatres around the world could show them in 3D.

It would be easy to credit superstar directors like these with the conversion to d-cinema. Lucas got the ball rolling by forcing the issue of digital projection. That, you could argue, helped push the studios to come up with a new standard. Cameron took things to the next level, providing in *Avatar* both a milestone in digital filmmaking and a compelling reason for digital exhibition. With its record $2.7 billion worldwide box office, *Avatar* convinced exhibitors that digital and 3D could be huge moneymakers.

In 2009, about 16,000 theatres worldwide were digital; in 2010, after *Avatar*, the number jumped to 36,000. A movie that criticized technology's war on nature accelerated the appearance of a new technology that many considered highly unnatural.

But the persuasive presence of Lucas, Cameron, et al. would have been for naught if the major distributors had not put in solid work behind the scenes—building on the foundations set by SMPTE and other groups, giving manufacturers a voice in the decision-making, and letting supply firms know well in advance the broad outlines of the new criteria. The July 2005 announcement of the DCI specifications simply ratified the fact that executives, technicians, engineers, and the most powerful exhibitors had designed a new system for showing movies.

The next task was to get the exhibitors to go along. Cameron, Lucas, and the rest were there to start building support. Even with the exhibitors in agreement, however, the path was still far from straight. It would be six years before digital cinema hit the tipping point.

Digital delay

Everyone could see how the major distribution companies would benefit. Besides saving money on prints and shipping—the public rationale for the switch—distributors could now monitor the number of screenings at any venue. The DCI specifications assured that a feature release would be set for only a certain number of runs in one venue. This would prevent off-hours screenings, a common practice of old-school projectionists who wanted to check the film or preview it for friends. In addition, distributors suspected projectionists of video-recording prints or bicycling them for overnight telecine copying. (For some time, however, prime sources of bootleg copies have been workers in postproduction houses.)

Multiplex exhibitors were also quick to grasp the benefits of digital. Screening film prints is somewhat technical, and it relies on mechanical skills that are growing rare. So anything the manager can do to simplify running the show is welcome. A film projectionist, represented by what was once one of the more powerful unions around, is also expensive. Teenage labor is not, and kids are familiar with many of the keyboard skills necessary to play digital "content." Any step toward automating a screening would be welcome.

Digital projection also opened up the possibility of using auditoriums for "alternative content" such as pop concerts, opera broadcasts, sports events, and business meetings with snazzy presentations. Mark Cuban of the Landmark chain envisioned families renting theatres to show their home videos on the big, bright projectors. Now the new megaplexes—some with up to 24 screens—

would become vast entertainment centers, squeezing revenues from massive economies of scale and maintained by low-cost labor.

There were bigger problems in selling digital projection to the creative community. Directors and cinematographers were not all convinced that the image was attractive enough, or at least as exquisite as film. So the distributors, and charismatic techie directors like Cameron, Lucas, and Jackson, had to insist that the image would meet anyone's standards. If 2K resolution wasn't quite there yet, 4K would be coming soon, and that would please even the most finicky professional. Moreover, filmmakers had already seen what a Digital Intermediate version could look like, and nearly everyone had taken up that tool.

Then there was the flattering appeal to artistic integrity. Filmmakers were assured that now their creative vision would be fulfilled. The film would retain its original look indefinitely; no more torn or scratched prints a week into a run. Every show in every town would purportedly respect what the artists had worked so hard to put on the screen.

With all stakeholders agreed on the advantages, why was the transition to digital so slow? Four conditions had to be met, and all were rather tough.

The setting of standards

Standards are of immense value to the film industry. It's to everybody's interest to have movies run at the same rate, but if you think you can improve on 24 frames per second (sometimes 25 in Europe), you will have a long climb. (Advocates of higher frame rates

have for decades run into opposition.) In Hollywood, wide-ranging technological change depends on the Majors cooperating with each other to mutual benefit, while they set up barriers to entry that exclude outsiders.

For the most part, innovations in sound, picture, color, and widescreen tended not to come from within the filmmaking companies but from outside firms and lone inventors. The real momentum for standardization comes when the American film studios, as an oligopoly, decide to throw their weight behind one system or another. This is what happened with the DVD and the Blu-ray disc. Once the decision-makers have surveyed the range of options out there, usually offered by very big technology companies, there ensues a process of negotiation, testing, and horse-trading before a standard is arrived at. When the Majors decide to accept a new technology, then the trade associations and manufacturers get into the act to create a smooth flow of supply.

By mid-2005, the DCI had put the functional architecture of digital cinema in place. Of course the guidelines wouldn't be absolutely rigid. For years SMPTE would be writing and revising standards for the implementation of the framework specified by the DCI group. NATO and the ASC would also be pressing for more tweaks. The companies, spurred by competition, would be innovating. For some time, new equipment would have to be "interoperable"—workable on many available systems, though not fully in compliance with the DCI specifications or SMPTE standards. In effect, there were several competing ideas about the standards: interoperability, NATO preferences, DCI guidelines, and SMPTE

ones. But even the rigorous SMPTE standards often neglected factors that were important to other parties. Although the DCI had laid out the architecture of digital cinema, filling in the details was a slow, ongoing process.

Feasible hardware

As so often happens, manufacturers didn't wait for a single standard to coalesce. Thanks to the withdrawal of the Hughes/JVC system, the Texas Instruments Digital Light Processing technology remained the strongest competitor and functioned as the de facto standard. It probably shaped the work of the DCI, since rethinking the entire problem afresh would have ignored the current reigning technology. The surge of 1.3K units in India, China, and South America helped the manufacturers create a critical mass of production, on which a more refined system could be built. In 2003, Texas Instruments made that refinement, recasting its DLP technology in a three-chip form that supported 2K—the minimum standard for the DCP.

Texas Instruments licensed DLP technology to only three manufacturers: Christie, Barco, and NEC. These companies had been aware of the DCI specifications by 2003. By the time the DCI guidelines were announced, projectors were ready: 2005 saw a huge jump in the purchase of 2K machines. In the same year Sony unveiled a system using modified Liquid Crystal Display technology, claiming that it was preferable for 4K projection. By end 2005, exhibitors had a choice of product.

But testing went slowly. To gain DCI certification, a piece of equipment had to undergo up to 350 tests, including everything from screen brightness and compression to encryption and security measures. Under DCI auspices, a new organization, CineCert, was set up in Burbank to provide authorized testing for American manufacturers, while a counterpart was established in Keio University in Japan. Through a kind of loop, tests brought out more problems that needed to be addressed through new specs, which then dictated more testing. Certification took a long time; the first fully compliant projector was approved in 2010.

Payment for installation

Money had always been the biggest sticking point. No one promised that digital projection was going to be cheap. A 35mm film projector costs between $20,000 and $50,000, and it will run for many years. The earliest digital projectors cost $150,000 or more, but the ones built in the wake of the DCI specifications ran between $70,000 and $100,000. In addition, the costs of maintenance appeared to be higher for digital; theatre owners initially claimed that they'd need up to $10,000 annually per auditorium. Worst of all, as anyone with a computer knows, digital technology has built-in obsolescence. One particularly grim forecast from 2002 estimated the life of a digital projector to be only three years.

The solution to the problem of conversion, emerging after some years of debate, was the Virtual Print Fee. The studios agreed to help exhibitors finance the changeover by paying a subsidy. Under one common arrangement, the VPF is collected by an intermediary,

known as a third-party integrator. The role of integrator was created to put studio funding at arm's length; direct support could invite antitrust scrutiny.

The role of the integrator is to loan the digital equipment to the theatre. For each booking the exhibitor makes, the film's distributor gives a sum to the integrator (negotiable, but by the late 2010s about $800). The VPF doesn't cover the entire cost; the exhibitor has to chip in. Eventually the equipment is paid off and belongs to the exhibitor. Depending on the deal, the VPF may cover some equipment upgrades and maintenance, but not the purchase of a new projector when the old one becomes obsolete.

3D, the killer app?

Even with VPF funding, the question for exhibitors was: How will digital grow my business? Initially, there was some speculation that theatres could charge more for tickets to digital screenings, but this tactic was quickly forgotten. What did make the difference, as the celebrity directors insisted, was 3D. Exhibitors could raise ticket prices to help pay for the digital upgrade.

In their 2005 ShoWest visit, the directors were coolly offering a promissory note. Stereoscopic cinema was far from an established niche. Cameron had restarted the 3D cycle in 2003 with *Ghosts of the Abyss*, in Imax and 35mm, but its earnings were fairly small. *Spy Kids 3D: Game Over* (2003) and *The Polar Express* (2004) did much better, but these were hardly worth massive conversion of an entire industry. Not until several months after the ShoWest pitch did a major 3D release generate excitement about the format.

Chicken Little opened to $40 million in November and went on to gross over $135 million domestically.

In a few years 3D did become something of a moneymaker. The studios stubbornly kept releasing films in the format, and theatres with digital equipment could reap the benefits of *Monster House* (2006), *Meet the Robinsons* (2007), and *Beowulf* (2007). Concert films, especially *Hannah Montana* (2008), helped too. The biggest supporter of 3D was Jeffrey Katzenberg, CEO of DreamWorks Animation. He had decided to make all the studio's features in 3D, and the strategy paid off with *Monsters vs. Aliens* (2009). Playing Imax houses as well as normal 3D ones, it was a turning point: it grossed nearly $60 million in the United States over its first weekend, more than half coming from 3D screens. What exhibitors had hoped for had come true: consumers would pay between $2 and $5 more for a 3D ticket.

Monsters vs. Aliens was one of sixteen 3D films released in 2009, far more than in any previous year. The roster included *Coraline*, *Up*, *Ice Age: Dawn of the Dinosaurs*, and *Cloudy with a Chance of Meatballs*. To accommodate this burst of hits, over two thousand digital screens sprang up, the biggest annual conversion to date. By the time *Avatar* arrived in December, exhibitors found their risk rewarded. After 47 days, over eighty percent of its box-office gross had come from 3D screenings.

By 2012, the initial excitement and box-office results of 3D had waned significantly. Income from 3D screenings was falling off, and the brand became tainted by poor-quality retrofits of movies shot

in 2D. Yet the 3D initiative worked superbly as a wedge prying open reluctant multiplexes. It was the Trojan Horse for digital projection.

The gradual settling on standards, the need for constant equipment testing, the need to fund installations, and the slow acceptance of 3D all served to delay digital conversion. In 2009, four years after Cameron's and Lucas's ShoWest pleas and the establishment of the DCI standard, the United States had only about 7500 digital theatres, just nineteen percent of the total. Only a few titles each year were released in the format. The tale of how American exhibition eventually went massively digital illustrates, once more, the tenacity of oligopoly power in media industries.

A matter of timing

Historically, exhibition has been the most conservative wing of the film industry. The theatre owner has the most to lose if a new technology fails to catch on. It was theatre chains' reluctance to install magnetic-stereo sound systems that led Twentieth Century Fox to redefine CinemaScope to an aspect ratio of 2.35, lopping off some picture area to make room for an optical soundtrack that would play on existing projectors. More recently, theatre owners had resisted the parade of digital sound systems that began in the 1970s and continued into the 1990s.

Digital projection was an even harder sell in the mid-2000s because theatre chains were recovering from a financial debacle. They had built many megaplexes in their eagerness to purge the one-, two-, and three-screen houses left over from the 1980s. By 2000, the United States had 38,000 screens, a new high. But there were

only so many first-weekend movies to go around, and attendance was simply spread among more venues. Stocks fell and debt rose. In the early 2000s, over a dozen major U.S. chains filed for bankruptcy protection. This was not the best time for multi-million-dollar expenditures on new gear.

The fallout from the theatre collapse yielded some benefits. Several thousand older screens, mostly in shopping malls, were closed. The biggest companies were able to buy smaller circuits and began a process of consolidation that would yield a powerful top tier of three chains: Regal, American Multi-Cinemas, and Cinemark.

Recovering from bankruptcy, the theatres faced another difficulty. After a high of over 1.5 billion patrons in 2002, attendance began to decline. Revenues were up because of rising ticket prices, but the client base was stagnant or shrinking. Perhaps something new could lure patrons back to the theatres? Digital projection by itself wouldn't do it, but maybe something else would.

In the meantime, exhibitors had found a new way to make screens more profitable: preshow advertising. What had previously been amateurish slide shows promoting local businesses, along with an occasional Coke commercial or charity pitch, became twenty-minute promotions for TV programs, movies in production, cell-phone services, and consumer durables. In 2003, these annoying curtain-raisers generated $350 million for exhibitors. Moreover, they were shown on low-resolution digital projectors, an innovation some executives saw as anticipating the next technology. Noted one: "This is a stepping stone along the way toward the day when we have a total digital presentation from start to finish."

Regal and AMC owned preshow advertising subsidiaries, and in the eventful year of 2005, they merged them into a single company called National Cinemedia (NCM). Soon Cinemark came aboard, so that the three major exhibition chains collectively owned an integrated supplier of preshow material. This position probably strengthened the chains' bargaining position with the studios, which welcomed the opportunity to showcase entertainment produced by the music and TV wings of their conglomerate parents.

At the same time, the major exhibitors had decided that digital projection of primary content was worth pursuing. Just as the studios cooperated to establish the DCI framework, so the three top exhibition firms worked together to assure that the standard was adapted. Regal, AMC, and Cinemark formed another company, Digital Cinema Implementation Partners, to coordinate the rollout. Controlling over 13,000 screens on prime sites all over the country, the DCIP consortium was in a position to guarantee that smaller chains would have to follow.

In 2007, the DCIP group began negotiating with the major distributors. Predictably, the question was how to pay for the switchover. The studios had already hit upon the Virtual Print Fee model using independent integrators. DCIP, in cooperation with the National Association of Theatre Owners, dickered throughout most of 2008 about a scale for the VPF before finally coming to agreement in September. Now, with the fees as collateral, the DCIP group could turn to Wall Street to obtain a line of credit.

But the timing was bad. The 2008 financial crisis froze credit markets, and Wall Street wasn't yet prepared to invest in the

changeover. Distributors and exhibitors chafed throughout 2009. 3D films were being released at the rate of over one a month, and there weren't enough screens to support long runs. After only a week, *U2 3D* had to make way for the Hannah Montana concert movie. Studios didn't want to leave money on the table, and exhibitors, who get a bigger share of the box office the longer the picture runs, were losing their long-term benefits. The release of *How to Train Your Dragon* had been scheduled for Christmas 2009, but it would have been wedged between *A Christmas Carol* and *Avatar*, so it was postponed until the following spring. *Variety* called the 3D market "a competitive bloodbath."

The strife relaxed in March of 2010, when Wall Street funding was finally arranged. The DCIP consortium was given access to $660 million to equip 14,000 screens over the next three years. Sony, Barco, and Christie cemented purchase agreements for thousands of projection units. Now that the big chains had begun the process, smaller circuits felt it was safe to proceed, and integrators could arrange VPFs for those who couldn't finance the switch themselves.

Laggardly exhibitors were warned that time was running out, and that most VPF contracts had to be signed by mid-July of 2012. The president of NATO declared that film prints would disappear very soon. In late 2011, Twentieth Century Fox sent out a notorious letter declaring that by end of 2013 at the latest, none of its titles would be circulated on film. The rush to convert was on. One company boasted that it installed 554 projection systems in seven states during September and October of 2011. During that year, an as-

tonishing 12,000 screens were converted. By mid-March of 2012, two-thirds of U.S. screens had gone digital. Screens were converting at a rate of twenty each day.

Globalizing digital

After Lucas had demonstrated the 1.3K standard for *The Phantom Menace*, a few American venues did embrace it. But once the DCI committee began its work, things were mostly put on hold. U.S. theatres held back, and studios released relatively few titles in digital versions. Europe and Asia, however, went ahead, installing over 230 digital screens between 2002 and 2004. A few aggressive entrepreneurs and emerging markets were quick to take advantage of the new format.

For example, Belgium's Kinepolis chain, which had early embraced the idea of the megaplex, installed fourteen digital screens. At a stroke Belgium had more digital screens than any other country in Europe. Kinepolis experimented early with "alternative content" as well, screening straight-to-video films and even clips from television news. Likewise, the installation service Arts Alliance Media started the digital push in the UK, setting up ten screens in the 2002 to 2004 period.

Before 2005, nearly all screens used the 1.3K or "e-cinema" format. This was also common in India, Brazil, South Africa, and other emerging markets. Most of these e-cinema networks used satellite or broadband distribution, and of course many venues continued to run DVDs. E-cinema also entered three major territories in East Asia. Between 2002 and 2005, Singapore, proclaiming itself a digital

hub for the next century, established 21 digital screens, a big number for a city-state with only 150 screens in all. Chronically underscreened Japan took the opportunity to convert 44 venues.

The biggest story, as in most things economic, was Mainland China. As an underdeveloped movie market, China needed theatres, and capital from the United States, Hong Kong, and South Korea flowed in to finance new multiplexes. The two major media agencies, China Film and the Shanghai Film Group, adroitly combined centralized government mandate and private investment to modernize rapidly. As early as 2003 China was adopting the 2K standard in some new houses, and its demand helped Christie and Barco maintain production while the American market dawdled. By the end of 2004, China had 93 screens, the largest number of any country.

Different funding models emerged. Ireland launched the changeover along commercial lines, hiring a specialty group and financing the process through venture capital. By contrast, in the United Kingdom, public funding was used to contract with Arts Alliance Media to refit and manage a circuit of digital art houses. In Norway, where the cinema sector was for the most part publicly owned, $2 million was devoted to studying the best way to shift the entire circuit to digital. Exhibitors, telecoms, and other stakeholders considered a range of options and patiently developed an efficient network that in 2011 enabled Norway to be the first nation to convert all its screens.

Over the same period, equivalents of North America's third-party integrators emerged to handle the conversion. China and Russia had their own mechanisms for the changeover, but in Eu-

rope two private companies took the lead. Arts Alliance of London partnered with the U.S. majors to convert and manage 7000 screens beginning in 2007. XDC of Belgium, like Arts Alliance, offered variants of a Virtual Print Fee program, along with theatre management services through software and the Web. XDC installed over a hundred digital screens by the end of 2005; six years later it participated in setting up and managing over 8000 screens in twenty-two countries.

As in North America, the wave of 3D hits was an abrupt accelerant. Between 2009 and 2010, the number of digital screens in Europe, South America, and Asia leaped from about 8500 to over 19,000. About two-thirds of them were 3D-capable. Africa and the Middle East joined the rush, converting or erecting nearly 300 digital venues. Russia went from 98 digital screens in 2008 to nearly a thousand in 2010. Building new theatres enabled emerging economies to skip 35mm altogether.

The expanding markets gave the supply companies vast new business. Christie reported that over 600 sites in Asia installed its projectors in 2009, while Barco claimed that it had eighty percent of all installed screens in China. This surge from the periphery gave impetus to the U.S. changeover as well. Brisk sales permitted the manufacturers to refine their systems and hatch new models.

As we'd expect, *Avatar* was partly responsible for the uptick. Of its $2.76 billion box-office revenues, over two billion came from foreign markets. Once more, China stands out. *Titanic* had helped open the Mainland market to Hollywood blockbusters, and *Avatar* was welcomed no less warmly. But China had long enforced a rigid

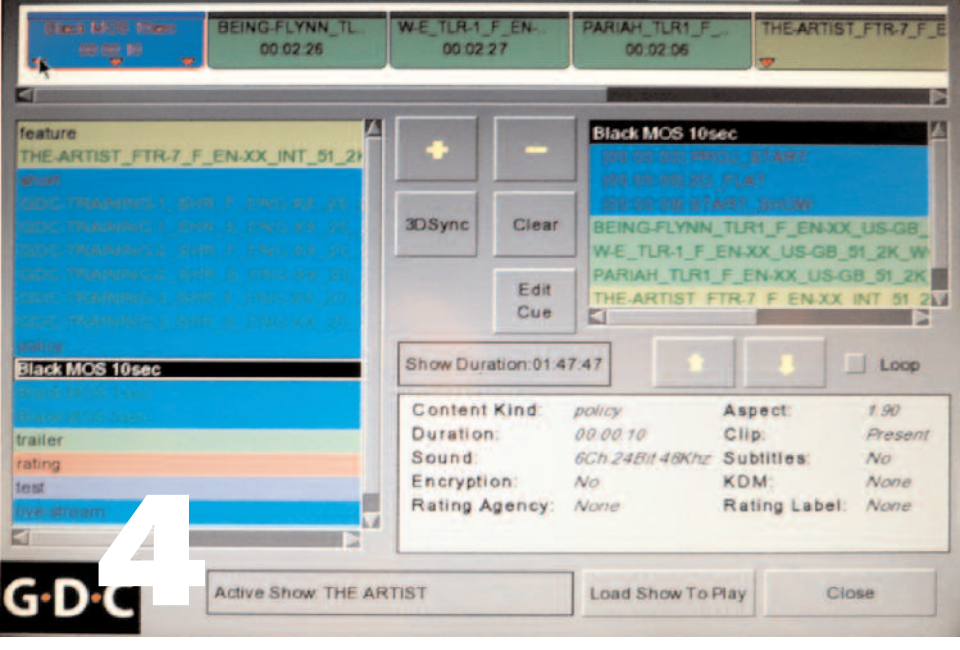
quota of only twenty imported films per year. According to the *Hollywood Reporter*:

> When Chinese officials pulled *Avatar* from theaters in 2010 because of its huge success and replaced it with a film about Confucius, moviegoers stayed away in droves. The audience wanted *Avatar* back, and when the government relented, fans paid as much as $100 for tickets.
>
> China's entrepreneurs responded by building more theaters, boosting screens in the country from 6,223 in 2010 to 9,200 in 2011, of which 5,000 are 3D. Box office hit a dazzling $2.02 billion in 2011, and the number of screens is expected to grow to more than 16,000 by 2015. "With the theaters built and owned by an entrepreneur class, there was upward pressure on the government to bring in more movies like *Avatar*," says MPAA chief Chris Dodd.

In February 2012, thanks to negotiations with Vice-President Biden and a personal letter from President Obama, China agreed to raise its import quota by admitting more Imax and 3D product.

By then, the foreign surge in digital installations had long been surpassed by American exhibitors. Once the VPF program was established, North American conversion moved quickly. From 2005 onward, the United States had far more digital screens than any other country.

In January 2012, over half of all 123,719 commercial screens around the globe were digital. It became clear that 3D, however much it was raising revenues, was not expanding the audience as promised. Nonetheless, Cameron, Lucas, and company had gotten the wish they made in front of the ShoWest crowd in 2005. After a few bumpy years, digital projection was king of the world.



Pay No Attention to the Man Behind the Curtain! (He's Not There, Anyway)

In establishing the Digital Cinema Initiatives program, the major companies solved many problems at a stroke. They prevented wildcat systems from confusing the marketplace and perhaps creating alternative sources of film entertainment. They saved the studios millions by eliminating the making and shipping of film prints. They devised a way to block piracy at one of its main access points,

the physical print passing through many hands. Exhibitors accepted the new rules of the game because they had little choice—distribution, as ever, rules—and because the DCI system promised them advantages of many sorts, from labor cost-cutting to smoother presentations and 3D capability. In the meantime, the distributors put in place a system that burrowed deep into the conditions of exhibition, shifting control of the show to automation and remote monitoring.

What are the nuts and bolts of digital projection? How is a show set up and run? How do exhibitors pay for the new gear? How do distributors track things?

Slippery standards

The list of constraints that the DCI committee set forth in 2005 is a mind-boggler for anybody not deeply into information technology. This 165-page document specifies minimal image qualities, audio characteristics, metadata, encryption, and security parameters. Here's a sample from the *nineteen* tasks assigned to the Security Manager (SM)—not a person but a program:

> Secure Processing Block behavior and suite implementations shall permit the SM to prevent or terminate playback upon the occurrence of a suite SPB substitution or addition since the previous suite authentication and/or ITM status query. The SMs shall respond to such a change by immediately purging all content and link encryption keys, terminating and re-establishing: a) TLS sessions (and reauthenticating the suite), and b) suite playability conditions (KDM prerequisites, SPB queries and key loads). "Prepsuite" command(s) shall be issued per (9) prior to the next playback.

The opacity of the DCI document disempowered traditional film workers and shifted their responsibility to the maintenance person working for the manufacturer or some other third party.

Still, standardization isn't as rigorous in the film industry as it must be in other areas, such as medicine or robotics. It's hard to completely regulate a business driven by showmanship, varying theatre architecture, and local customers' habits.

As a result, many technical standards tend to be in flux, constantly adjusted to practical concerns. What, for instance, is the CinemaScope aspect ratio? Designed originally to be 2.66:1, twice as wide as the 1.33 format, it went to 2.55 and then to 2.35, partly because of Twentieth Century Fox's responses to the market. Later the anamorphic standard was modified again, to 2.40. And of course 'Scope films are routinely shown with masking cutting off part of the frame. The Society of Motion Picture Engineers, which has historically tried to stabilize technical standards, often played catch-up, refining or revising standards that were already at best just common practice on the ground.

The DCI committee was well aware of the fuzziness of standard-setting and so the 2005 document did not propose much in the way of engineering specifications. There were some baseline requirements, such as 2K and 4K capabilities, 12-bit color depth, 24- and 48-frame per second playback, and heavy security encryption. But the software and hardware meeting these conditions remained to be developed. Nor did the committee demand a specific delivery system, allowing for transporting the DCP via physical media, satellite, or network. By and large, the document laid down the ar-

chitecture of the system and left the details of implementation up to manufacturers.

Moreover, instead of demanding strict fulfillment on all counts, the document set a minimum benchmark. Projection systems could be DCI-compatible in many respects but not "compliant" in the sense of being ready to pass stringent tests according to all the committee's conditions. It was up to SMPTE to create a set of more precise standards, which it did in a series of publications. Meanwhile, the National Association of Theatre Owners issued its own guidelines for digital presentation, as a bid to pressure both the DCI and SMPTE into favoring certain possibilities (such as the easy shifting of films between a multiplex's screens).

The result was something of a hodgepodge. As late as March 2011, most of the thousands of digital projectors in use hadn't been certified as fully DCI compliant. Through 2012, new equipment was still being tested. Moreover, certain enhancements, like closed captioning and enhancements for viewers with vision problems, were not initially specified by the DCI but were required by the SMPTE specifications. As of late 2011, no studio was consistently sending out films in the SMPTE standard, and only some projectors were able to handle the strict DCI one. Distributors currently send "content" in a more forgiving format that adheres to basic DCI guidelines. That format, designed to be temporary, is called "interoperable." As usual in the film industry, the practical demands of ongoing production and exhibition would not stand still to satisfy an engineer's ideal of absolute standardization.

Files coming to a theatre near you

Despite the lack of pure standards, a fairly routine workflow has been generated. A movie shot on film stock will typically pass through a Digital Intermediate process, being scanned into files and manipulated to achieve the photographic look desired. That can be rescanned back to 35mm film, creating a master negative that can yield release prints. More likely, the DI will serve as the basis of the digital files shipped to theatres in the Digital Cinema Package.

If the movie originates digitally rather than on photographic film, the process goes a little differently, and there come to be several digital versions of the movie. These versions proliferated to serve the different needs of production, distribution, and exhibition.

Digital source material. The original sound and image elements—the shots and soundtrack—may be recorded in specific formats, either tape-based or file-based. Those formats can vary a lot among themselves. *The Girl with the Dragon Tattoo*, for example, was shot with the Red One camera on the company's proprietary format R3D, but other cameras don't use that format. So the footage was converted to other sorts of files for viewing and postproduction work.

Any major film nowadays is likely to use many digital video and audio formats. All these assets are usually stored in the distributor's vaults.

The Digital Source Master (DSM or DCM). This is the master copy of the finished film, somewhat comparable to a 35mm film negative. It can be in any format selected by the filmmakers. It's the

basis of the distribution master, the home video master, and a version for archival storage.

The Digital Cinema Distribution Master (DCDM), in formats determined by the Digital Cinema Initiatives. This is the finished film unencrypted and uncompressed, providing "content" at 2K and/or 4K resolution. Roughly speaking, this is the digital counterpart of a 35mm release print.

The Digital Cinema Package (DCP). This is the film and associated material compressed and encrypted for theatrical playback. It's somewhat comparable to the delivery of a 35mm print on shipping reels.

The Digital Cinema Distribution Master as played (DCDM*) Once the DCP files are opened and decompressed, they yield image and sound identical to what's encoded on the DCDM. The place of DCDM* playback in the system is roughly comparable that of projecting a 35mm print from platters.

Eventually, the film will materialize on the **optical disc formats** DVD and Blu-ray (and in Asia, VCD). Later it will be on streaming video, cable transmission, and Web-based platforms.

The DCP is the pivot of theatrical projection. This ensemble of files comes on a hard drive, usually one that can hold a terabyte. (Sometimes operators refer to the drive itself as the DCP, but it's really only the vehicle for it.) The DCI group modeled the DCP on analog film projection. The architecture calls for the feature to be split into reels, as in a 35mm print. Since there is no physical stuff involved, a digital reel is defined as a stretch of time "having a specific duration chosen by the content provider." Each reel works as

a folder containing a set of track files: one for image, one for sound, one for subtitles, and perhaps others for closed-captioning or other components.

At a higher level, the reels are nested within a Composition, an enclosing folder that arranges the reels in correct order. Compositions are differentiated by the language of each audio track. A European DCP of an American feature might contain several Composition playlists for French, German, and Italian soundtracks besides an English-language one. In addition to the feature's files, called "essence" content, there are many files for security encryption and for playback.

On the DCP, a feature may consume anywhere between 50 and 300 gigabytes, with other files and metadata filling out the hard drive. The purpose of the projection system is to reconstitute the high-quality DCDM for the audience. The DCP is decompressed in the same way that a DVD or Blu-ray player "expands" the compressed information on the disc into a bright, clear video image. The goal, according to the DCI specifications, is a picture that is "visually indistinguishable from the original DCDM image."

To yield that picture, you of course need a projector. All 35mm film projectors used the same basic design, but digital projection rests on two quite different technologies.

The Texas Instruments system, known as DLP for Digital Light Processing, uses millions of tiny mirrors to reflect light from the lamp house onto the screen. There's one mirror for every pixel in the image, and each one tilts according to the shade of color in the

image. The mirrors are flipping on and off thousands of times each second.

The mirrors yield only shades of black, white, and gray. Color is added either from the lamp itself or from a filter inserted before the light hits the chip surface. The on/off position of each micro-mirror is coordinated with the appropriate color. "For example," a Texas Instrument promotional document explains, "a mirror responsible for projecting a purple pixel will only reflect red and blue light to the projection surface; those colors are then blended to see the intended hue in a projected image." The DLP technology is the basis of many HD television monitors, with a single chip controlling the mirrors.. Theatrical projection uses a three-chip configuration.

The alternative technology is Sony's Liquid Crystal on Silicon (LCoS) system. Here the light from the lamp is polarized and then controlled by electricity sent across a layer of liquid-crystal substance. A mirror reflects the light back across a grid of pixels that is activated by electrodes underneath. Interestingly, the Sony system has an analog basis: gray levels vary continuously with the voltage passed over the liquid-crystal layer. The image becomes digital only when it's converted into discrete pixels. As with the DLP system, color is added. A beam-splitter reassembles the red-green-blue components into a full-color image.

Texas Instruments doesn't manufacture projectors. It currently licenses its technology to three companies: Christie, Barco, and NEC. Sony, by contrast, makes projectors using its LCoS system. The scenario brings to mind the computer market, with TI as Mi-

crosoft as the licensor to third parties and Sony as Apple, offering a top-to-bottom ecosystem. Like Apple as well, Sony has sought to push the standards. It is the prime force behind 4K projection and has experimented with 6K and 8K resolution in capture and scanning devices.

The projector isn't a stand-alone item. Just as reels and platters feed 35mm projection, a server is needed to send the unencrypted, decompressed content to the projector. Typically, there's one server unit, also known as a media block, per projector. Major suppliers of servers include Doremi, GDC, and Dolby. In a multiplex, there may also be one or more multiple-drive units storing films, trailers, ads, and the like. This setup is called a "library management system" or a "theater management system." It allows the exhibitor to program several auditoriums from a single point, either a monitor linked to the storage system, or even a laptop in an office. For the sake of redundancy and backup, the DCI specs recommend that exhibitors keep a copy of the film on both a management system and the server tied to the projector.

In the booth

So much for the gear. What does a digital projectionist do with it? To find out, I visited our local Sundance cinema here in Madison, Wisconsin. It's a six-screen complex that mixes art-house and mainstream titles. Manager Merijoy Endrizzi-Ray and projectionist Hal Theisen took me through the process of setting up a show. Merijoy has worked in art-house exhibition for many years in Madison. Hal has been a projectionist since 1972; his first feature was *Lady*

Sings the Blues, and he remembers the great era of 70mm fondly. He is our city's last union projectionist working full-time.

The film show is in effect shipped to theatres along two channels. The physical channel conveys the DCP on a hard drive to the venue, where the DCP is then loaded into the projection system. The other channel is based on security measures. The film won't play unless it's opened with a Key Delivery Message, a file containing a long alphanumeric string. This is sent to the manager or the operator, usually by email. The DCP and the KDM are never sent together, even though, for reasons we'll see shortly, there is a near-zero chance that a pirate could open the files even with the key.

Hal's task starts with opening the carrying case holding the DCP. The drive is a slim matte-finish brick, a little taller and skinnier than a trade paperback. In North America, the case is color-coded by supplier: Deluxe favors gray, Cinedigm likes yellow, and Technicolor provides a gaudy tangerine case padded with pink foam. Standardizing the cases alerts Federal Express, United Parcel Service, and other courier services to the precious cargo.

The DCP is tailored to one projector and its server; it will play only on that system. So the files have to be fed into the server. For a feature the process of "ingestion," as it's called, can take between a few minutes and an hour or so. It proceeds fastest when the projector/server combination isn't running a film, and when the hard drive is inserted directly into a server port. The pace of ingestion is shown as a percentage of file-filling, as on any computer.

Trailers for coming attractions may be included on the feature's DCP, or an assortment may show up on a separate drive, usually

labeled "Trail Mix." The exhibitor can select from them, depending on what the venue will be showing.

Just having the film on the server doesn't mean it's ready to play. This is where the parallel channel comes in. In her email, Merijoy has received the KDM, matched to a particular projector-server unit. She gets a unique KDM for each screen. The agency that prepares the keys has been told the make, model, and serial number of each piece of equipment in the complex. Having copied the KDM file onto a flash drive, Merijoy can plug that into the server. The key recognizes that the projector has been certified to run DCI material, and it acknowledges that this particular film will play on the server.

This scheme makes piracy almost impossible. The pirate would need to have not only the DCP files and the key, but also access to the only server-projector tandem that will recognize the key. Moreover, if anybody tries to hack into the DCP without the KDM, the encryption files will render the content useless.

Once the equipment recognizes the key, Hal can prepare the playlist. The playlist controls everything that happens onscreen. It's displayed on a monitor attached to the server, and Hal can use a keyboard or touch controls to type in or drag and drop items as necessary. Hal selects when the film is to start, what trailers are to accompany it and in what order, and even the timing of lights going down and up. He also programs five to ten seconds of virtual black leader to be sandwiched in among the theatre logo, the trailers, and the feature.

After the screening starts, Hal and Merijoy can track its progress. The server's monitor reads out the passing hours, minutes, seconds, and even frames. Tabs on the interface display the parts of the show and can bring up information about running times, subtitles, aspect ratio, and similar information. Another monitor displays all projection events, with 0:00 marking the beginning of the program. For a trailer just before the feature, the screen might display the minutes and seconds consumed by a trailer and a feature:

4:03 Preparing to play…

4:04 Clip started [HUNGER GAMES_TRL]

5:41 Preparing to play…

5:43 Clip started [TINKER-TAILOR_FTR]

5:43 Automation label triggered [LIGHTS DOWN]

5:51 Automation label triggered [VOL 5.0]

In addition, the server monitors the available storage space on the server, the drive temperature, the condition of each reel on the DCP drive, and network connections to the projector and to other servers.

The projector has a monitor as well, and that can provide information about power, lamp life, lens condition, and aspect ratio. There are settings for different digital formats, like 1920 x 818 or 2048 x 858. But the film on the DCP files is already calibrated for aspect ratios and other physical dimensions, so adjustments of the projector are rarely necessary.

In short, virtually everything that 35mm presentation had left to the projectionist's care and judgment is now automated. Even focusing the image isn't necessary because during installation, the

lens is locked into place. Hal can't get to it; the lens assembly is accessed through another password, held by the staff of the maintenance company.

An art-house exhibitor can't always plan far ahead; it's not clear how long a specialty film can play, or when a desirable title will be available. On Monday, Merijoy confirms that a film will open or continue on the following Friday. For a first screening, the DCP arrives on Wednesday or Thursday, with the KDM coming at about the same time. Thursday is a busy day, with Hal loading and testing several titles that will open on Friday.

The digital key is valid for a certain period, sometimes only for a certain number of shows. Commonly, each week new keys for all six Sundance screens are sent to Merijoy, and these are used to reset the servers. The film, however, doesn't have to be re-ingested. A reminder pops up on the server screen if the movie's key is close to expiring.

The Sundance 'plex has a library management system as well, a sort of master server that backs up the servers linked to the projectors. The management system keeps track of what's playing on all the screens. Through touch or keyboard controls, Merijoy and Hal can open up a file and see the information that would be displayed on each server's monitor. In principle, by connecting wirelessly to the library management system, a manager could program and keep track of the entire complex from a laptop in an office, or in a Starbuck's. Merijoy declines to do this, largely because she wouldn't know what was happening in the auditoriums, but the possibility of remote control is there. Moreover, each server logs the screening

activities, so a complete record of every show is available to various parties.

Given two primary demands of the DCI initiative—sending films out more cheaply and securely, while making the new system attractive to exhibitors—the DCP system works quite smoothly. Hal sometimes misses the noise of movie film, though. If something went wrong, you could hear the projector chatter, and a bell would go off. Now, with six projectors humming like vacuum cleaners, the only signal of trouble is a flashing light that turns from green to yellow. (If it flashes red, there is very big trouble.) But the aura isn't completely gone. Like some other theatres playing off-Hollywood product, Sundance has retained a few 35mm projectors.

Virtually a print, actually a fee

All this sophisticated equipment costs a lot of money. The prices aren't made public, largely because of nondisclosure agreements between theatre operators and manufacturers. But figures between $50,000 and $125,000 per projector/server unit are commonly mentioned. Costs rise if new sound systems also have to be installed.

The biggest chains were able to fund the changeover from that massive infusion of credit provided by Wall Street in 2007–2008. Other chains, as well as small exhibitors, were forced to join in. Some theatre owners found the money to pay for the conversion, but many didn't have such deep pockets. Manufacturers were reluctant to lease equipment, and the recency of the conversion didn't allow top-flight units to be available second-hand.

For many exhibitors the best solution was the Virtual Print Fee, that subsidy paid by the distributors. When the exhibitor books films from the distributor, the VPF helps pays off the equipment, and eventually the exhibitor owns it. The studios claimed that the conversion was "cost-neutral" for them. The DCP format saves them money on preparing and shipping prints, so they're purportedly passing the cost of film prints on to the exhibitors. Some observers claim that actually the cost of prints was greater than the amount funded by the VPF; during the early discussions, studios quoted the cost of a print as running $1500 or more. So even with the cost of preparing and shipping the DCP drives, the typical fee of $800 saves the studios considerable money today, not just down the road.

The VPF money isn't paid directly to the exhibitors. Theatre owners must enroll with a third party, known in the States as an "integrator." One of the biggest integrators is Cinedigm (previously AccessIT), operating in tandem with Christie; in addition, Sony offers dedicated VPF programs. Typically the integrator signs an agreement to supply, install, and maintain the equipment. This process can be subcontracted to local or regional companies. For example, Strong Ballantyne of Omaha has branch offices around the Midwest to fulfill VPF contracts with chains both big and small. Overseas, the equipment is sometimes installed by teams sent by the projector manufacturer. European firms like Arts Alliance and XDF play the role of integrator.

The VPF comes with strings attached. The constraints are hard to verify because of nondisclosure agreements, but some terms have

leaked out. A deal may require the theatre to convert all screens, so that every auditorium can play DCPs. This assures the rapid spread of the standard. Other arrangements apparently forbid a programmer to rent a 35mm print if a DCP is available. Even if the theatre keeps some film projectors around, the DCI-compliant machines must be paid off before running 35.

Most onerous to non-Hollywood distributors is another provision: A VPF must be paid for every film shown on a VPF-supported projector. If an exhibitor wants to play a film from outside the Majors, the distributor has to pay a VPF. The studios and the supply companies argue that this arrangement is fair. Why should the Big Six establish the specifications and fund the purchase and installation of the gear in order to play a competitor's film? On the other side, an analogy occurs to some. If I use a bank loan to buy a car, the bank has no say in what I do with it. It certainly can't forbid me to use it for drive-up banking at another financial institution.

The constraints on the print fee indicate once more that the Hollywood majors behave like the oligopoly they are. Controlling the prime product, they work in concert to limit competition from outside. Exhibitors with VPF arrangements are obliged to one degree or another to book films as DCPs rather than in 35mm or other formats. Independent distributors have less incentive to provide films in the DCP format if they must pay the VPF cost. Some 2K projectors can, properly hooked up to a Blu-ray player, screen 1.3K material that a small distributor provides, and usually the movie will look the better for it. Nonetheless, the distributor will still have

to pay a VPF. In various ways, the VPF may limit what is screened in art-house and repertory cinemas.

NOC, NOC, who's there?

Digital projection can be considered a process of "de-skilling." A novice can quickly learn to set up a show, without ever knowing the fine points of projection. Still, the booth needs some attention. Projector lamps must be changed, and mechanical parts checked and replaced. The installers or a local expert can supply routine maintenance like this, but sometimes there are bigger problems.

What happens when an encrypted file can't be opened? Or when it's corrupted? Or the show mysteriously stops? What if the operator, even consulting the manual, can't fix the problem? Enter the NOC.

Network Operations Centers, also known as Data Centers, are part of broader Information Technology management. They're used whenever a business or government agency has a network that needs 24/7 monitoring. All Fortune 1000 companies have NOCs scattered around the world. NOCs coordinate railway systems, military systems, banking, and police and fire departments. Amazon has a NOC in Seattle, Walmart has one in Bentonville, Arkansas, and AT&T has a monstrous one in Bedminster, New Jersey.

Users can phone NOCs, but they aren't designed to be call centers or help lines. Essentially NOCs are handling and storing vast streams of data from computers, video cameras, and other inputs. The goal is keeping track of things pertinent to the business or agency. Of course even large staffs can't do this simply by eyeballing the flood of data. Instead, the software is set to notice anomalies

and to call them to the attention of the humans. So if a police camera outside a Tube stop in London picks up a pattern of unusual activity, say three men running purposefully toward a woman, that information is pulled out of the stream and sent to an operator for inspection.

Once film theatres became digital, they acquired the ability to connect to NOCs via the Web. An owner who funded the purchase of the DCI-compliant equipment might well choose to pay a NOC to provide oversight and help. But exhibitors who sign up for a Virtual Print Fee program are required to sign up for a NOC. NOC services may be supplied by the equipment manufacturer (Sony, Christie's, Barco, GDC et al.) or by the installer, such as Ballantyne Strong or Film-Tech Cinema Systems of Plano, Texas. An integrator may also offer NOC services, as Cinedigm does in the United States and XDC does in Europe.

By the standards of giants like AT&T, a theatre-monitoring NOC tends to be fairly small, with only a few dozen staff at workstations. Yet the purpose is the same. A projector/server combination and a theatre-management system are connected via the Internet to the NOC. The NOC monitors the state of the system. It can keep track of lamp life, parts conditions, Net connectivity, and the like. The software can send alerts to the theatre management for upcoming maintenance and can do troubleshooting. The software is also trained to notice problems—glitches in playback, dropped subtitles, auditorium lights suddenly going on. Anomalies are called to the attention of the specialists at the workstations.

Christie initiated one of the first NOCs in 2003, and it now monitors over 3700 digital screens across the United States and Canada. From its California facility it "manages the configuration of systems, provides help-desk services to customer staff, and access to local technicians with local parts to provide on-site repair and support." The Shenzhen, China center maintained by GDC monitors ten thousand screens.

A projectionist who confronts a problem can call either the supplier of the DCP, or the key-fulfillment agency, or the NOC. Most NOCs don't plan programming or chase down encryption keys from distributors, but at least one will perform these services as well. The Film-Tech NOC will even remotely power up and down the auditorium. Says the company's brochure: "The projection booth can literally operate for months without anyone ever entering it."

The next step in automation, already taken in some 'plexes, is to eliminate the booth altogether. A typical "boothless projector" will be hung from the ceiling in the rear. One Missouri venue has projectors mounted high above the lobby, pointed into the auditoriums. The theatre management system can occupy a small closet, and the DCPs can be ingested there and sent to the projector/server units. Eliminating booths allows theatres more space for revenue-generating activities. "Today we're looking at all sorts of food services and additional businesses," notes one manager. "In the past, you always had a big multiplex and it was surrounded by restaurants or a theme park environment or something. For the first time ever you can actually integrate those businesses into the complex, where you can actually have an entertainment center."

The show must go on, if remotely

The projectionist and the manager have substantial support from the NOC, but in the meantime they've shared a lot of information with it. In order to collect the Virtual Print Fee, the exhibitor must play the studio's film on a contractual basis—for a certain period, a certain number of times per day, and so on.

In earlier times, a dodgy exhibitor might run a film more often than it reported, cheating the distributor of income. Or an exhibitor might trim shows of a poorly performing title, substituting something more popular and depriving the weak film of playing slots and box-office payback. In those predigital days, distributors sent out "checkers," staff disguised as ordinary moviegoers, to see that theatres were running films according to contract.

Now the projector/server mating provides real-time screening information to the NOC, and that flows to the distributor. Says an executive at a firm supplying NOC services:

> All of the NOCs notify the studios about the performance of the systems. Uptime is critical or VPFs will not be paid. Exhibitors cannot miss more than a certain number of allotted shows and still receive their checks.…All NOCs provide the studios with access to the playback logs to ensure the movies booked are actually played.

According to the same source, some NOC systems monitor the use of the equipment outside normal shows. "Some of the traditional NOCs go so far as to ensure the equipment is not used for anything else, and the theatre will be back-charged for the use of that equipment."

At a minimum, then, the performance information forces the exhibitor to abide by the booking contract. But it also means that even with full knowledge on the part of both exhibitor and distributor, the advantage lies with the distributor.

Distributors allow operators some leeway for quality checks, such as running a film at odd hours to make sure it plays properly. Still, the NOC is tuned to those anomalies too. One exhibitor remarks, "If I'm demoing a movie, they may not know it's a demo. They might wonder why I played a movie at 9:30 AM." Prudent operators phone the NOC to let authorities know when they're running test screenings.

In a highly automated environment, things can proceed blindly. Once, here in Madison during the1970s, a snowstorm paralyzed the town. Someone at a theatre had left the automated system on. Even though the theatre was closed (and no one could get to it), the show went on: lights up, lights down, curtain parts, film runs, film halts, lights up, film rewinds.…

More vaguely, some exhibitors worry about the NOC as a policing or surveillance operation. No one can object to a mechanism that enforces contracts, but screening schedules have long had a certain fluidity, especially in small venues and art houses. On-the-fly compromises and flexible arrangements emerged from negotiations among managers, programmers, bookers, and distribution staff. People knew one another and made allowances for specific circumstances. When so much of scheduling and operation is transferred to servers, playlists, and NOCs, human contact is likely to wane. The projectionist isn't the only ghost haunting the multiplex.

Anyone who has ordered something with a credit card online has already submitted to the oversight of a NOC. But when your livelihood depends on smoothly functioning film screenings, you could be understandably apprehensive about turning your business over to unknown others in unknown places. Hacking, malware, and human error are spectres hovering over all of IT. As one theatre owner told me: "[The NOC] could shut off every theatre at one time and in the process send a little message, like the Jolly Roger in *Independence Day* when the guys bugged the mother ship."

The studios embraced new technology, and they had the power to set standards and restructure the flow of product. The multiplex exhibitors wanted to cut costs, simplify presentation, and open up new revenue sources, such as 3D and preshow ad packages. This meshing of interests allowed Hollywood studios to control exhibition to a new degree, and without much risk. Who wants to own theatres anyway? They entangle you in mortgages and real estate crises, and they have the awkward habit of going into bankruptcy. Today if you control the files, the encryption, and the network, you control the show.

What's left for the managers? Well, there's selling popcorn.

5

The Road to Harmony

The conversion to digital presentation was designed for an industry that deals in mass output, saturation releases, and quick turnover. A movie comes out on Friday, fills as many as 4,000 screens around the country, takes in most of its box-office revenue within two or three weeks, and then shows up on VOD, PPV, DVD, BRD, or some other acronym. These ancillary outlets yield much more to the studios, but the theatrical release is crucial in establishing the awareness of the film that powers the aftermarket.

Given this shock-and-awe business plan, movies on film stock look wasteful. You create, ship, and store several thousand 35mm prints that will be worthless in a few months. (I've seen trash bags stuffed with *Harry Potter* reels destined for destruction.) Pushing a movie in and out of multiplexes on digital files makes more sense.

It has been comparatively easy for the national chains to make the digital switchover. The Big Three—Regal, AMC, and Cinemark—now control nearly 16,000 screens, forty percent of the U.S. total. Solid capitalization and Wall Street investment, economies of scale, and cooperation with manufacturers allow them and other big chains to afford the upgrade. The National Association of Theatre Owners defines an "independent" exhibitor as one that isn't a publicly traded company and that holds fewer than a thousand screens.

The graph has a very long tail. Of the 5700 theatres in the United States and Canada in early 2012, over twenty-five percent have just one screen. Some of these 1620 venues are drive-ins, but most are "hardtops." At the next level up from single-screen venues, a theatre is categorized as a "miniplex" if it holds between two and seven screens. These 1900 or so venues constitute another thirty-five percent of U.S. theatres; they and single-screeners account for over half of all theatre sites in the United States. Beyond them is the category of multiplex proper, an exhibition complex housing between eight and fifteen screens. There are 1474 of those, or another twenty-six percent of the total. Finally come the megaplexes, venues with sixteen or more screens. At 695 sites, they constitute only about twelve percent of all theatres.

But what matters to distributors is not the number of buildings but the number of screens. In 2009, seventy-five percent of all U.S. screens were in facilities of eight screens or more. Needless to say, most of these multiplexes and megaplexes belonged to the big chains. As of July 2010, Regal owned an average of twelve screens per site, Cinemark had thirteen, and AMC had fourteen. AMC's first megaplex in Dallas held twenty-four screens; its Burbank, California facility today has thirty.

Megaplexes draw on an audience estimated to lie in a fifteen-mile radius, while smaller theatres typically pull people from three miles away. In population centers, the more screens, the bigger the income. The ten top-grossing U.S. theatres in early 2012 included three in Manhattan, two in suburban Washington, D.C., and others in Boston, Paramus, and Burbank. They average twenty screens each. No surprise, then, that the big three chains, along with another three or four nation-wide companies, dominate the major markets. In small towns and cities, a single-screen venue or a miniplex can scarcely compete.

For a snapshot, look at Amarillo, Texas in late March 2012. The United Artists Amarillo Star Stadium 14 & Imax was screening twelve current releases, some in 3D, one in Imax, and a couple of holdovers only twice a day. The Cinemark Hollywood 16 was running the same titles, with the addition of *Casa De Mi Padre* and two anniversary screenings of *Casablanca*. The Westgate Mall Cinema 6, an older venue, was screening *Hugo, War Horse*, and other releases from the late winter, as well as films that had moved quickly out of first-run houses, including *Red Tails* and *Big Miracle*. Tickets

were $2 at all times, and all Westgate screens were running 35mm. The single-screen Varsity in nearby Canyon, Texas (pop. 14,500), was playing *Dr. Seuss' The Lorax* in 2D with ticket prices at $5 for adults and $3 for children.

Megaplexes like the Amarillo Star Stadium and the Cinemark Hollywood yield the bulk of the rentals that flow back to the distributors. The Big Three chains provide just over half of the $10.2 billion annual domestic box-office receipts. Hence the Big Three's eagerness to partner with the studios in adopting the Digital Cinema Initiatives plan. Their consortium Digital Cinema Implementation Partners, aided by their trade association, took the initiative in negotiating the Virtual Print Fee program. The sooner everyone converted, the sooner the big firms would benefit.

The big chains own some small houses, and those in major markets can flourish. But what about the smaller fry—the independent regional circuits, the local chains, the small-town miniplexes, the older second-run houses like Amarillo's Westgate Mall Cinema and the single-screen houses like Canyon's Varsity? Even before the digital changeover, their numbers were waning.

The 1999–2001 bankruptcies slimmed the bigger circuits somewhat, but as they recovered, they began a new wave of consolidation. They shut down their peripheral screens, expanded their complexes, and bought up rival chains. Between 2000 and 2002, over 1400 single-screeners and miniplexes were closed. The survivors have struggled with declining attendance, the need to upgrade the physical plant, and the emergence of new sound systems and 3D. Since 2007, the total number of U.S. screens has remained fairly

steady, but multiplex and megaplex installations have swollen by 2000 screens, while smaller facilities have lost about the same number.

Now the clock is running. Soon the majors will cease releasing 35mm. Most theatres that want to play studio releases will require a DCI-compliant projector and a server for every screen. To pay for the upgrade, many exhibitors will want to take advantage of the Virtual Print Fee. But many VPF programs are due to end signup during 2012.

Today, for small houses and circuits, the financing of digital conversion is the biggest problem since the rise of cable and home video in the 1970s and 1980s. How will they cope with it?

All 'plexes aren't created equal

The smaller houses may get films weeks or months after their initial release, and they may present shows only on weekends. Some small theatres play mainstream product, while others are "art-house and repertory" cinemas, specializing in foreign and American independent films, along with documentaries and revivals of older classics. Either way, they have very slim margins, and even when run as not-for-profit enterprises, they are vulnerable to the slightest shifts in the film business.

Start with the commercial houses. Any mainstream theatre housing fewer than seven screens is either a sign of a tiny local market or a vestige of distant days, or both. Scanning the American theatre landscape is like looking over an archaeological site and seeing traces of life forms from many eras.

The single-screen theatre may be a leftover from the classic era of exhibition. If it was a picture palace, it's likely to have been split up. That was the fate of Milwaukee's Oriental Theatre, built in 1926 with a capacity of 2400. It was eventually divided into three auditoriums. Or the duplex or triplex might be left over from the era of the roadshow house. During the 1950s and 1960s, large, freestanding venues were erected to play big films like *The Ten Commandments* and *The Sound of Music* for months on a reserved, high-priced basis. When the roadshow economy collapsed in the 1970s, the big venues that survived were chopped into smaller screens.

Alternatively, a duplex or triplex might be of more recent vintage. Several were purpose-built in the 1960s when exhibitors moved away from downtown areas to suburban shopping centers. Most historians trace the modern multiplex to this effort to anchor two or three screens to adjacent retail spaces. The exhibition chain AMC took its name—American Multi-Cinemas—from its focus on building complexes containing two or more screens during the 1960s. Stanley Durwood, AMC founder, thought: "If I had another crummy picture upstairs, I could double the gross."

Other companies followed Durwood's lead and increased the number of screens. As shopping centers grew from strip malls into vast, enclosed structures offering acres of parking, and as suburban young people became the primary audience, the movie house of the 1970s was likely to be a multiplex.

No film lover who lived through that era is likely to forget it. Although the theatre was typically an anchor for the mall, it was surprisingly austere, as if any decoration would suggest money wasted.

"Minimalist moviegoing," historian Douglas Gomery has called it. With small screens, distorted sound, cramped seating, and sticky floors, these boxes within boxes gained a reputation for being the worst way to see a film. Projectors were often misaligned with the screen, and the sound of one auditorium usually leaked into neighboring ones. The video arcades in the corner of the lobby only added to the air of desperation. Who wouldn't want to stay home to watch cable or VHS instead of visiting these shabby, slapped-together venues? Many of the smaller theatres facing problems with digital conversion are relics of the 1970s multiplex era.

Grim as they often were, the mall multiplexes demonstrated the advantages of new technology and economies of scale. A central box office and concession stand allowed for efficient traffic and saved on labor. The projection booth could be large enough for many machines, all using the platter system. Now one operator could supervise several shows at the same time. Print makeup and initial threading were really the only tricky parts of the job. Once set up, the show could run and rewind many times at the push of a button.

Some projectionists had welcomed platter technology, but then they realized that managers could turn the show over to minimum-wage teenage labor. At the same period, carbon-arc lamps were replaced by xenon bulbs, which could purportedly be changed by a neophyte. Multiplexes began the wholesale automation and deskilling of projection that would find its consummation in the digital conversion.

As saturation booking replaced gradual rollout, people in every town, from the metropolis to the hinterland, would see the week's big movies on the same weekend. More screens were needed. Exhibitors also noticed that the early multiplexes, drab at best and tacky at worst, could use an upgrade. The result was the megaplex, and most historians credit the Canadian firm Cineplex Odeon with launching it.

After building an initial facility of eighteen screens in downtown Toronto, Cineplex Odeon opened a movie theatre at the top of the Beverly Center mall in Los Angeles in 1982. It boasted fourteen screens and scrupulous attention to cleanliness and comfort. Auditoriums varied in size, allowing specialty films to be matched with smaller audiences. Perrier was available. A vast display of titles and show times let the patrons mull over their options. The spacious modern design, with wide windows giving onto a breathtaking view, showed that theatres could be splendid again. And profitable: with so many screens, offerings could be tuned to demand. A hit film could play on two or more screens, while a weak performer could be moved to a smaller house. A movie theatre was now an "entertainment destination."

Cineplex Odeon expanded into hundreds of North American markets and became a top exhibitor. Its rivals saw the benefits of scaling up. Theatres added digital sound, stadium seating, love seats, armrest cup holders (an AMC invention), popcorn popped in sunflower oil, tickets bought with credit cards, and other amenities. Where there was land, megaplexes moved out of shopping centers and became hermetically enclosed, free-standing facilities, like

the picture palaces and the gargantuan roadshow houses; no more lines spilling out into a mall. This is moviegoing as anybody born after 1975 has come to know it.

But nothing lasts forever. When exhibitors decided to expand megaplexes, new architectural constraints emerged. You might need to build another booth to accommodate your new screen or your Imax facility, and that worked against smooth design. Eventually the shiny new facilities became scruffy. All that foot traffic over twenty years, all those kids flinging soda at the screen and rocking the seatbacks with their knees gave the surviving megaplexes an air of flamboyant dilapidation. An emblem of the change came when the Beverly Center 13, as the Cineplex Odeon flagship was now known, became tatty. It was shut down in 2006 and demolished in 2010.

The decline of the older megaplexes contributed to the 1990s theatre-building boom, which in turn triggered the bankruptcies of 1999–2001. But receivership allowed chains to flush out the tired or underperforming sites. Amarillo, for example, shed many screens, with the Westgate Mall Cinema 6 the last mall cinema left there. Unsurprisingly, Amarillo's Cinemark Hollywood 16 and the Star Stadium opened in 1998 and 1999 respectively. Part of the second generation of megaplexes, today they own the city's first-run market.

Local boys make good

For decades exhibiting movies has been a family business. Many regional exhibition chains were founded by fathers and brothers and staffed by sons, daughters, and in-laws. The Midwest's Marcus

chain of 700 screens originated in 1935 with grandfather Ben and today is run by son Stephen and grandson Gregory. More modestly, Smitty's Cinema, a nine-screen movies-and-eats franchise in Maine and New Hampshire, was the brainchild of three brothers.

The smaller the venue, the more likely you'll find a family in charge. The single-screen Cozy in Wadena, Minnesota, has been run by the Quincers since 1923, with the founder's great-grandson in charge today. Dirk and Jeri Reinauer preside over the Sunset Theatre in Connell, Washington. Tom and Barbara Budjanek, who bought Pennsylvania's Ambridge Family theatre in 1967, were still running it in 2012.

Families pass theatres to each other. The venerable Roxy in Forsyth, Montana, was bought by a couple in 1967. They sold it to their projectionists, one of whom kept it going with his wife. (The theatre went digital in 2010, just in time for its eightieth birthday.) From 1947 to 1959 the Wayne Theatre in Bicknell, Utah, was operated by a husband and wife. Another couple bought it and ran it until 1994, when they sold it to a third husband and wife. A fourth family acquired it in 2008.

Then there are the Goetzes. In the middle of farming country, Monroe, Wisconsin became a center of—what did you expect?—beer and cheese. The town's Joseph Huber Brewing Company, founded around 1845, is the home of the tasty Berghoff. In 1926 an enterprising UW graduate modernized the town's cheese industry by creating the Swiss Colony, a mail-order firm that offered cheese, sausage, and baked goods. While many small towns are shrinking, Monroe's population has stabilized at around 10,000 for decades.

Leon Goetz had managed local theatres before he opened the spanking-new Monroe in 1915. To build a 500-seat film theatre in a town with 4500 people reflects not only the growing popularity of cinema but Goetz's conviction that the business had a future. The farms and towns nearby would supply customers; people came to the county seat to transact business and legal affairs. Then as now, the nearest competitors to a Monroe movie house were over twenty miles away.

With his brother Chester, Leon moved up a level by erecting the Goetz Theatre, which opened in 1931. It was of semi-Moorish design, with faux balconies and moody cloud-and-star lighting on the ceiling. Light brown brick and darker brown terracotta inlays adorned the outside. The lobby was forty feet high, with a gold finish and many trappings and fixtures. The screen was twenty feet wide and fifteen feet tall. With 800 or more seats (estimates vary) and a modern sound system, the Goetz Theatre impressed the *Monroe Evening Times*:

> It should raise inestimably the respect with which talkies are looked upon locally and attract many persons who heretofore did not care to see pictures under the conditions in which they were shown.

In all, the Goetz was said to have cost $125,000.

Leon retired to Florida but Chester stayed in the business, opening the Goetz Junior on Christmas day, 1936. It claimed to be "ultra modern," with the Western Electric Mirrophonic sound system and streamlined design elements, like glass brick. Holding only 275 seats, it sometimes showed films not screened at the Goetz across

the street, but other times it would screen the same films—even on the same night, with reels rushed back and forth.

Soon Chester had competition from the Chalet, a 500-seat house around the corner. According to local memory, Chester cut ticket prices and then bought the floundering Chalet as a third Goetz house. Chester's sons Robert and Nathan joined the business. Under Robert's leadership, their company built the Sky-Vu Drive-in in 1954, and like the Goetz home base it has been running continuously ever since.

The postwar decline in movie attendance hurt the circuit. The Chalet and the Goetz Junior closed. In the 1980s and 1990s two screens were added at the Goetz from adjacent retail spaces. Visit the Goetz today and you'll see the original auditorium. There are fewer seats, but it's still very big.

The third generation

Robert's son, Robert "Duke" Goetz, has a masters degree in landscape architecture from Harvard, but he's been running the family business for several years. He does everything from programming the movies and designing the website to wrench-and-hammer work on the place. He's worked on heating, carpentry, and acoustics.

Duke Goetz has a commitment to showmanship and quality of presentation. The Goetz website has old-fashioned razzle-dazzle, including neon colors. (Chester liked bright colors in his houses.) Convinced that DTS is the best sound system for his venues, Duke outfitted his smaller auditoriums with hard-hitting speaker systems. He installed tip-back seats, stadium seating in one house, and one

belt-driven projector for steadier images. Duke will also tell a gaggle of teenagers to shut off their cell phones, and will watch to make sure they do.

Despite the commitment to quality, and programming that brings in family fare matched to local tastes, business has been rocky. Duke recalls some high points: 1993, when *Jurassic Park* did spectacularly at both the Goetz and the Sky-Vu; 1998, when *Titanic* brought in as many as a thousand viewers a night; and 2002, his best year in recent memory. That year was an exceptional spike for the industry as a whole, with estimated admissions of 1.57 billion, so just about anything less looks like a decline.

Then, in 2007, business began to slump and stayed flat through 2011. The only bright spot that year was *Twilight: Breaking Dawn*; the midnight premiere drew about 150 customers, mostly high-schoolers.

A good night at all three indoor screens is 300-350 tickets, but the Sky-Vu can reliably draw many more. Duke recalls one evening when the drive-in had over 1100 customers and sold 114 handmade pizzas. Today, even with competition from another local drive-in, the Sky-Vu's summer schedule bolsters the bottom line significantly.

Why the falling off in recent times? I had expected the standard macro-explanations: the Internet, video games, etc. But Duke's main rival is sports. In a town like Monroe, high school sports are central to community life, so Friday night football and basketball games draw not only teens but parents. With the rise of women's athletics, the middle and high schools schedule plenty of games across the weekend. Add in the fact that televised football in the

fall breaks up Saturday (the UW Badgers) and Sunday afternoons (the Packers), and you have a client base that isn't focused so much on movies.

After three tough years, Duke looks at things realistically. He hires part-time staff to project, sell concessions, and keep an eye on the house, so he's his only full-time employee. He adds: "I have not been paid since August 2010." Digital, he admits, is chancy in this business climate. "But without digital, I'm gone."

Duke Goetz saw his first digital screening around 2000 at a convention of the National Association of Theatre Owners. What attracted him was the edge-to-edge screen brightness. Judging by what I saw (from down front), the 1.85 image in 35mm at the Goetz is quite sharp, but Duke had long been unhappy with the falling-off of light on the edges of any film display. The tendency is exaggerated in anamorphic (2.40) films, which have become more common. And the bigger the screen, the greater the tendency toward a hot spot in the center. In addition, Duke liked the punchier color in digital.

So he was intrigued. "I'd have loved to have done it ten years ago." But then there was still debate about trustworthy delivery systems (the Net? satellite?) and the cost was astronomical, about $125,000 per projector. In summer of 2011, though, it became clear that the digital wave was cresting, and time was running out for 35mm film. Also running out were the plans for the Virtual Print Fees.

Duke took the plunge, arranging for three new NEC projectors from companies and installers he's known for years. Duke isn't going with 3D, partly because he can't justify the upcharge and

partly because he's not convinced it attracts enough extra business. One Monday in December 2011, the installers arrived to refit the place.

I was there for the Friday night 35mm shows, and I re-visited on Tuesday. The whole changeover was less dramatic than I expected. In two of the houses, the old projectors were simply moved aside and the new ones sat stolidly in their place. The gigantic platters were stacked in the hallway. Reels, rewinds, and splicers sat in corners. All of the 35mm projectors had been relatively new, but one is now in the lobby as a historical artifact.

Duke thinks that digital will be even better for the Sky-Vu. The big screen is a problem for dimness and edge-to-edge brightness, but it should respond well to a digital beam. An indoor screen is porous to allow sound through, but that means that some light is lost. A drive-in screen is solid and should reflect light better. The brilliance of the digital illumination should also help counter chronic drive-in problems like fog, ambient light, moonlit nights, and some flaws on the screen.

The flattening of attendance at the Goetz is part of a trend. For several years total U.S. domestic admissions have hovered between 1.3 and 1.5 billion. Admissions in 2011 were at the low end of that zone, and ticket revenue fell four percent from 2010 (which was still enjoying the benefits of *Avatar*).

Duke closed out his 35mm shows on the worst weekend exhibitors had seen since fall 2008. Will digital bring Monroe area customers back? Once people realize that they will get high-quality presentation in their hometown, perhaps they won't drive half an

hour to Freeport or an hour to Madison. But best not to prophesy. Duke realizes he's taking the same sort of risk that Leon and Chester took when they built the Goetz at a cost of what would be $1.7 million today. "My motto," he says, "is go digital or die."

Harmony, not far from Prosper

The record for mom-and-pop single-screeners might be held by the little town of Harmony, Minnesota. The JEM Theatre on the main street, a family-owned and –operated house built in 1940, was acquired by Bob and Hazel Johnson in 1961. They ran it for twenty-five years. It passed through the hands of five more couples before Michelle and Paul Haugerud acquired it in 2002.

Paul and Michelle met in San Francisco, where Michelle was working for Bear Stearns and Paul had served in the Navy. In 1994 they moved to Harmony to be near Paul's family. There they raised six children while Paul started a paint and drywall business and Michelle began a career in Web design. "When we bought the theatre," Paul explained, "we knew it was gonna make no money. We knew it was gonna be basically like doing community service."

With a population of about a thousand, Harmony sits close to the Iowa border. As *Prairie Home Companion* reminds us every week, people of Norwegian descent are found all over Minnesota. What you may not know is that certain areas are also home to Amish communities. Waves of migration made Harmony a center of Minnesota's Amish culture. Local businesses serve the five hundred households in the town, and tourism brings in some income too. One of the big attractions is Niagara cave, containing fossils

pre-dating the dinosaurs. There's also a major biking trail and a fall foliage tour.

The JEM (representing the first initials of some family members) helped knit the town together, and under the Haugeruds it became a unique institution.

They made a solid team, with Paul's expertise in carpentry and engine repair matched by Michelle's money-management skills. Paul, with no previous theatre experience, learned to thread up the platter projector. "The first few weeks, I would literally sit there with sweat rolling down my face as I pushed the start button. I'd be so nervous I did something wrong." Paul introduced screenings with announcements and jokes. The Haugeruds knew most of their patrons, but at every screening there were fresh faces from nearby towns in Minnesota, Iowa, and Wisconsin.

The JEM screened only on weekends and just once each day, at 7:30. Paul's and Michelle's jobs made any other schedule impossible. During football season, Fridays brought in few teenagers, but Saturdays were better and Sundays were quite good. Overall, the 200-seat house averaged around 55 each night. On snowy nights, a few souls would usually brave the Minnesota winter to come see a movie.

The Haugeruds ran the JEM as a family business. There was no paid staff. The Haugerud kids sold tickets and snacks and helped with cleanup. Friends and volunteers came out as well. Michelle made the preshow video slides of ads for local businesses. Even with low overhead, the theatre barely broke even. All tickets were $3.

"We've always kept prices low," Michelle explained, "so families that are financially hardshipped can still get their kids out of the house."

Most of the JEM's programs were subruns—movies that had opened nationally two or three weeks before. To avoid courier service costs, Michelle and Paul would make midnight drives to pick up prints from other towns. "I'd call and they'd just be breaking down their print from their last show on Thursday," she says. "I'd say, 'I'll be there in fifteen minutes,' and at midnight I'd go get the print for Paul to make up on Friday."

Snack concessions are the core of every theatre's income, but even here Paul and Michelle offered deals. They priced their candy at a dollar and a big tub of popcorn at four bucks. Soda was sold in plastic bottles, to allow for recycling and to keep costs down. Instead of getting concession items from theatre suppliers, Michelle bought them in bulk at Sam's Club.

The JEM popcorn developed a following. High schoolers came to pop and bag it for football games. Paul and Michelle encouraged people to bring their own buckets to be filled at a fixed price; some people showed up with shopping bags. The Amish didn't come to the films, of course, but on some days you could see a horse and carriage lingering outside while the driver was buying a supply of popcorn.

The Haugeruds were generous with free passes as well. Over the years, they have donated hundreds of free passes to help local organizations raise money. At other times, Michelle realized, passes are a good form of marketing. "Give out one, and three more people will come along to pay."

The JEM wasn't just for movies. Youth groups held meetings there. Kids had their birthday parties there, accompanied by a movie or a videogame. The Haugerud daughters had slumber parties in the auditorium; after a movie, they settled down, if that's the right word for a slumber party, in sleeping bags down front and in the aisles.

Many in Harmony believed that the JEM brought business to town. Julie Barrett, owner of the Village Square Restaurant across the street (and famous for her daily pies) said, "When people go to the movie, they stop at the Kwik Trip, and our hardware store is open until 6:30, so you know they might try to kill two birds with one stone when they come to town."

Over the situation hovered the fate of every small town—the hollowing out of the center by the big-box stores down the road. Pull off any interstate highway, and you'll see that the main streets of small towns have turned into empty storefronts, municipal offices, and struggling boutiques. When the JEM faced the need to go digital, Paul was concerned. "If we take one more thing away it's going to hurt the community. I'm scared to death that main street is going to look like Harmony in the 1980's when I was growing up. It was pretty bare."

Decisions

In late spring of 2011 Paul and Michelle decided to try to go digital. A new projection system and sound processor would cost $75,000. Duke Goetz, with three screens, embraced the VPF program, but that wasn't an option for the JEM. "We've tried to run it by ourselves

and keep it independently owned, but it's gotten to the point now where we're looking for some help," Paul said in July. "It was a difficult decision to ask for the community's help," Michelle wrote on her website. "We never wanted to ask for support, but we knew the public deserved to know why we may have to go out of business."

They began a fundraising drive. A young patron named Kirsten Mock decorated an old red juice jug for donations and put it on the candy counter. Paul and Michelle set up a designated savings account with a local lawyer's name attached to make sure people understood that any donations would go only to the projector. A list was kept of all who put their names on donations, and the money would be refunded if the target sum weren't reached.

The problem was that the JEM, privately owned and operated, wasn't a nonprofit. Donations were not tax-deductible, and local government agencies couldn't normally supply grants or other aid. During 4 July celebrations, however, a "Harmony Goes Hollywood" event featured a room in the Historical Society set up with an old projector and theatre seats, with clippings and photos showing the JEM over the years.

A local woman tipped Twin Cities media to the campaign. It was good timing: The U.S. press was starting to notice the nationwide digital conversion. News outlets and TV stations covered the JEM's crisis. Minnesota Public Radio picked up the story.

By fall, when the campaign had raised about $7200 locally, Paul and Michelle found a nearly new projector for $55,000. They managed to borrow the $48,000 they needed from a local bank. By

shouldering the loan themselves, they showed the public that they were committed, and this gesture boosted donations.

On 11 November, the JEM screened its first movie in the Digital Cinema Package format, *Dolphin Tale*. On that weekend Paul thanked Kirsten for kicking off the fundraising and gave her a lifetime pass to the JEM.

Now Paul and Michelle had the equipment, but they still needed to pay for it. Later in November, the Trust for a Better Harmony stepped in to help. Enabled by a generous gift from Gladys Evenrud, the Trust and a Minnesota agency for community development arranged for a flexible loan package. As a result, the JEM now needed only $28,000, to be paid from community donation. The loan sparked still more offerings to the projection bank account.

But on 13 January 2012, Paul died.

Commander of the local American Legion, he was buried with military honors. He left behind Michelle, his six children, his parents, four brothers, and two grandchildren. The town grieved. "There's nothing he wouldn't do to help someone else," a friend said.

Michelle remembers weeks going by in a blur. Friends brought over way too much food. "I had to freeze a lot of it." She decided she simply had to move forward. She had a full-time job and had children at home, but she would keep running the JEM.

In February, a fundraiser was held at Wheelers Bar & Grill. The event had been planned before Paul's death, but now it gained a new urgency and poignancy. Wheelers is named for its big roller rink, where Paul had helped out often. Across the day Wheelers held a silent auction and some beanbag and darts tournaments.

Those, along with food, drink, and music, raised an astonishing $16,000. Along with the digital account, that yielded enough to pay off the bank note for the projector. The balance of the debt was retired, and any funds left over were targeted for upgrades. In spring 2012 Michelle was considering 3D conversion in a year or two.

On the Saturday I visited, *The Hunger Games* drew a robust crowd, mostly groups of boys, groups of girls, and families, with a few elders sprinkled in. Nearly everybody bought concessions. Many arrived with buckets for popcorn. The ticket booth was decorated with Easter rabbits and a Darth Vader helmet.

Upstairs, I saw a little room off the projection booth with a porthole. It was Michelle's and Paul's "private screening room," she explained. They would watch the show from an old car seat.

On the sidewalk outside, Girl Scouts were selling cookies. In the tiny lobby, dozens of construction-paper stars were pinned up, each bearing the name of someone who donated money. Above the booth hung a framed lobby card for *It's a Wonderful Life*.

Money on the table

> Looking into the future, unless we can stop or reverse the trend, we will no longer have any theatres in towns with less than 15,000 or 20,000 people. And many will be deprived of the right to see a movie.
>
> Richard H. Orear, President,
> National Association of Theatre Owners, 1980

Orear's worry that small towns would lose their movie houses reminds us that as soon as 'plex fever took hold, local cinema was at risk. The elimination of small houses is a long-term process that

has simply become more visible in this moment of sudden technical upheaval.

It would be easy for cinephiles to bemoan what's happening in Monroe and Harmony. We celebrate the look and feel of film, and we'd like to see old picture palaces and modest but dignified local houses become temples dedicated to 35mm. But we don't pay the shipping and heating bills for those houses; we don't dicker with bookers who won't let us have prints when we need them. We like the idea of film surviving, but the practical people who actually deal with exhibition day by day can't afford to satisfy our tastes.

Let's also remember that purists would doubtless be scandalized at what film prints looked like when they made their way to the Goetz or the JEM in the old days, six months or more after release. The New JEM opened in September 1940 with *Rancho Grande*, a Gene Autry Republic western that had been released back in February. The Goetz Junior opened with Eddie Cantor's *Strike Me Pink* nearly a year after it premiered in Manhattan. In April 1956 the Monroe Chalet was running a 1951 Roy Rogers movie. Most viewers in the 30s, 40s, and 50s saw battered prints that had been in circulation for years. By comparison, digital projection looks heavenly.

The Goetz and the JEM remind me of the single screen of my childhood, Schine's Elmwood in Penn Yan, New York. That theatre is long gone, so part of me rallies when I learn that somewhere a local house can still bring in the community. As far as I'm concerned, it can show film, 2K, Blu-ray, or vanilla DVD. When I was a kid, I wouldn't have cared how those images got on the screen.

In towns like Monroe and Harmony, the theatre, and the neighborly spirit it represents, is more important than emulsion. In one photo of the Goetz in 1936, the marquee reads: TODAY 2 BIG FEATURES IN GERMAN. One of the fundraising events for the JEM was Football Monday, when Paul and Michelle projected a Vikings-Packers game. They couldn't charge admission, but they sold tickets for drawings of prizes donated by local businesses.

The National Association of Theatre Owners made an effort to help small venues through its Cinema Buying Group, a cooperative made up of exhibitors in low-revenue or second-run situations. Eventually the CBG negotiated VPFs for some members. Estimates vary, but around 1600 screens may have been converted under CBG auspices by late 2011. That still left fifteen to twenty thousand unconverted screens in the United States and Canada.

How many of them will disappear? David Hancock of *IHS Screen Digest* suggests that five percent could close during the conversion. That number sounds small, but it amounts to nearly 2000 screens. John Fithian, president of NATO, expects a more serious purge. Any house with ten screens or less, he suggests, is at risk. "For low-grossing theatres, [digital] is just not affordable." History shows that theatres can shutter and screens can vanish. We saw it in every decade. It was happening as recently as the 2000s, when 3400 screens, mostly in the smaller venues, went away.

Then the pressure was chiefly financial; now it's technological as well. Our situation hearkens back to 1928, when the studios agreed to shift to talking pictures. Put aside your pity for those actors like George Valentin in *The Artist*. Harder hit were the people

who worked at the more than four thousand movie theatres too small, too remote, or too poor to be wired for sound. Of course that conversion took place during the Great Depression. But our economy isn't looking exactly vigorous, and in some ways today's hardware changeover is more hazardous.

For one thing, 1930s audiences didn't have cable and Netflix to make staying home more attractive. For another, digital adds nothing palpable to the product. With talkies or widescreen images or stereophonic sound, exhibitors could point to significant upgrades. With digital, a clean picture and uncompressed sound are the selling points—features that many viewers don't care much about. Besides, who's to say that already struggling theatres will see any uptick in business with digital? What if they still fall by the wayside, as so many have already? All the rhetoric from the Majors and NATO, as Duke Goetz encapsulated it, is "go digital or die." What if the vulnerable theatres die anyway? Their owners would go out of business owing more than ever.

Surely the distributors and the big chains realize this. Hollywood, people like to say, doesn't want to leave money on the table. But more and more the long tail is a waste of resources. Why bother to prepare and ship a DCP to a theatre that yields a box-office take of less than $300 per day, from which the distributor gets about only half? Or from a theatre that shows only on weekends? Distributors willing to cut overhead and back-office operations may well regard the small houses and circuits as simply a pain in the neck.

Many decision-makers would be happy to let people in small towns wait a couple of months and catch the film on VOD or disc

(rented from a gas station, since the video stores are gone too). These formats are profit centers to a degree that "low-grossing" theatres are not. As long as the megaplexes publicize the must-see movies, people will know what to buy or rent or stream. If you live in the countryside and you really feel the urge to catch the latest hit, get in your car or pickup and drive an hour to a 'plex. No vehicle? Too young to drive? Wait for the video.

As digital projection allowed the major distributors to consolidate their power, it offered a way to streamline and downsize exhibition. The 1600 American single-screen venues are especially vulnerable. For the industry, it seems, any part of film culture that preserves some history or takes root in a community is simply a nuisance. Michelle Haugerud puts it simply. "They don't care if we go out of business."

6

Art House, Smart House

▲ The Art Theatre, Champaign, Illinois

Not all the small theatres play studio product. Many single-screeners and miniplexes show what's known as art-house movies. The label is attached to films in foreign languages and British English, low-budget independent U.S. dramas and comedies, documentaries, revivals, and restorations. In the trade it's called "specialty" programming.

Some art houses contain several screens, but most have only one or two. Being small, they face the same risks as the Goetz in Monroe or the JEM in Harmony. But those venues benefit from showing mainstream movies. The art houses have much more rarefied programming. In March 2012, while the Goetz and the JEM were screening *The Hunger Games*, the Capri (Montgomery, Alabama)

was showing the Iranian film *A Separation* and the Sebastiani (Sonoma, California) was showing the U.S. indie *Friends with Kids*, along with the 1936 MGM picture *San Francisco* in its Vintage Film Series.

Small and aimed at a narrow market, art houses have always lived a precarious life. The conversion to digital projection could wipe out many of them. As of late 2011, only a small proportion of those venues were DCI-compliant. "Art houses are not going to be able to do this," predicts one operator. "We will lose a lot of little theatres across the country."

Almonds and prestige pictures

'Plexes, whether multi- or mega-, tend to look alike. But art and rep houses have personality, even flair. One venue might be a 1930s picture palace saved from the wrecking ball and renovated as a site of local history and a center for the performing arts. Another might be a sagging two-screener from the 1970s spiffed up and offering buns and designer coffees. Another might look like a decaying porn venue or a Cape Cod amateur playhouse (even though it's in Seattle). The screen might be in a museum auditorium or a campus lecture hall. When an art house is built from scratch, it's likely to have a gallery atmosphere. Our Madison, Wisconsin Sundance six-screener hangs good art on the walls and provides café food to kids in black bent over their Macs.

Most of these theatres are in urban centers, some are in the suburbs, and a surprising number are rural. Some are privately held

and aiming for profit, but many, perhaps most, are not-for-profit, usually owned by a civic group or municipality.

Something else sets the art and rep houses apart: their audience. It's well-educated, affluent, and old. Juliet Goodfriend's survey of the Art House Convergence association indicates that children and high-school and college students make up only about thirteen percent of patrons. A third of the total are over sixty-five. As Juliet puts it, "Thank God for the seniors!" However much they like popcorn, they love chocolate-covered almonds more.

In the whole market, art houses are a blip. Figures are hard to come by because the National Organization of Theatre Owners doesn't track art houses systematically, and the nonprofit ones don't show up in many counts of commercial cinemas. Neither Montgomery's Capri nor Sonoma's Sebastiani theatre appears in NATO's most recent list of exhibitors. Jack Foley, head of domestic distribution for Focus Features, estimates that there are about 250 core art-house screens. In addition, other venues present art-house product on an occasional basis or as part of cultural center programming.

Art-house and repertory films typically contribute no more than five percent to the $9 billion in ticket sales in the domestic theatrical market. Of the one hundred top-grossing U.S. theatrical releases in 2011, only six count as art-house fare: *The King's Speech, Black Swan, Midnight in Paris, Hanna, The Descendants*, and *Drive*. These are the art-house equivalents of the studio tentpoles, but only on relative terms. Taken together, these titles yielded about $309 million, which is $40 million less than *Transformers: Dark of the Moon* took in all by itself.

As these audience-friendly examples indicate, the top-grossing art-house films are in English, showcasing name stars and strong genre ingredients. More strictly art-house items like *Take Shelter, Potiche, Bill Cunningham New York, Senna, Snow Flower and the Secret Fan, Certified Copy, Page One, The Women on the 6th Floor*, and *Meek's Cutoff* grossed only one to two million dollars each in 2011. Other "specialty titles" took in much less. Miranda July's *The Future* attracted about half a million dollars, *Uncle Boonmee Who Can Recall His Past Lives* grossed $184,000, and Godard's *Film Socialisme* took in less than $35,000. A distributor once told me: "Picking up an art film is like peeing in your blue serge suit. It makes you feel better, and nobody notices."

Despite their minor role in the financial side of the industry, the art houses are sustained by prestige. Of the six top-grossing titles from 2011, five were Academy Award contenders. When a studio finances or picks up a prestige picture, it's likely to release it through a boutique division, such as Fox Searchlight, Sony Pictures Classics, and Focus Films (Universal). There are also independent distributors, some quite small and others, notably Lionsgate and The Weinstein Company, functioning as mini-majors.

Apart from offering prestige pictures, art houses are the last vestiges of old-fashioned showmanship. The owners mount trivia contests, membership drives, sing-alongs. They help out with local film festivals. They bring in filmmakers and local experts for Q & A sessions or set up long-distance interviews on Skype. They screen those plays, operas, ballets, and concerts that attract a broader arts audience. The bigger entities, like the Bryn Mawr Film Institute and

the Jacob Burns Film Center, offer courses in filmmaking and appreciation, along with special events for children, teenagers, and other sectors of the community.

Everything is about localism. These people know their customers, often by name. They sense the currents of taste crisscrossing their town. The success of the Alamo Draft House reveals that Austin has a demographic hungry for the kung-fu classic *Dreadnaught*, an *Anchorman* Quote-Along, or a compilation of the worst CGI work in film history. In Los Angeles, the Cinefamily attracts a crowd ready to watch *Film Socialisme* alongside *Battle Royale*, Pat O'Neill films, and the 1927 *Casanova*. Art house operators and programmers aren't only about making money but about weaving unusual cinema into the fabric of their town's culture and subcultures.

Not just the coffee, but it helps

As an institution, the American art house has enjoyed a remarkably stable tradition. A few European imports played mainstream theatres in the 1920s, sometimes to great success, but on the whole the U.S. market wasn't hospitable. Since the major studios owned the best and most powerful theatre chains, it was hard for outsiders to break into the market.

After a few sporadic attempts, the International Film Arts Guild, a sort of film society, created a consistent venue for foreign releases in New York's Cameo Theatre in the fall of 1926. German films, including Expressionist classics, dominated the Guild's programming, but *The Battleship Potemkin* also proved a big hit, as did a long-running revival of *Intolerance*. By the end of 1927, a handful of theatres

in New York, Washington, Baltimore, and Los Angeles had dedicated themselves to an art-house repertoire. One group of entrepreneurs modeled their work on the Little Theatre movement that had created small local drama ensembles across the country. The Little Cinema movement spread from the major cities to smaller ones like Rochester, New York, where the Little Cinema, founded in 1929, continues to run today. There were also filmmaking clubs that screened foreign releases for study purposes.

The coming of sound wiped out most such venues, making those that survived, such as Boston's Fine Arts Theatre and Los Angeles' Filmarte, even more prominent showcases for prestigious imports. German, British, and French films were the most popular, and many have remained classics: *M*, *Maedchen in Uniform*, *À Nous la Liberté*, *The Grand Illusion*, and some Pagnol titles. Some drew good box office. *The Private Life of Henry VIII* grossed half a million dollars, or $3.5 million in today's currency—a sum that a contemporary distributor would greet happily. As Europe became enveloped in war, the supply of product shriveled, but the Museum of Modern Art's library of 16mm classics kept interest alive in America's campuses and community libraries.

What Tino Balio has called the foreign film renaissance on U.S. screens began almost immediately after the war. Marginal distributors brought over Italian Neorealist films, British comedies and dramas, and miscellaneous titles from France and Scandinavia. Dedicated theatres sprang up around the country, often near college campuses. When a late 1940s depression curtailed Hollywood pro-

duction, many theatres changed to a partial or total foreign-film policy. A 1949 *Variety* article noted:

> Postwar surge of art theatres, born as an outlet for the flock of British and foreign-lingo pix which hit this country after V-J Day, is now slowing to a normal growth. In the U.S. at the present time there are 57 theatres which are out-and-out art houses and 226 additional flickeries which play foreign-made product part of their time.…With the exception of Newark…every city of 200,000 or over now sports at least one art theatre.

By 1958, the *Film Daily Yearbook* listed over 340 cinemas in 41 states playing "first-run art product." Many used the word "art" in their names.

It's remarkable how strictly today's template was fixed during these early decades. Then as now, art theatres sent out program information to customers on a mailing list. The venues were often decorated with modern paintings and offered upscale amenities like tea, coffee, and imported candy. A 1928 *Variety* article mocked a screening of *Moana* and *Grass* at the Chicago Playhouse: "Double bill but the gross still singular; house could charge for alleged coffee, now free, and make payments on percolator; $3,400 last week, enough for first payment."

Like our art houses, those of the prewar and postwar decades depended on buzz; their films were very much critic-driven. Then as now, British films led the pack—not just *Henry VIII* in the 1930s, but also *Henry V* (1944), *Hamlet* (1948), and *The Red Shoes* (1948), all proving very successful. *Henry V*, released in the United States in 1946, played for four years and earned two million dollars. For-

eign imports could attract Academy Award attention; *Henry VIII* and *Hamlet* won Oscars. Of the foreign directors whose films did well in the United States, many wound up working in Hollywood. Ernst Lubitsch was the first to make the move, impelled by the American success of *Madame Dubarry* in 1920, and he was followed by other directors, such as F. W. Murnau and Victor Sjöström. In the 1930s and 1940s Hollywood absorbed Fritz Lang, René Clair, Julien Duvivier, Jean Renoir, Anatol Litvak, and many other émigrés. The pattern recurred in recent decades, with Paul Verhoeven, Wolfgang Peterson, John Woo, and many British and Australian directors finding Hollywood careers after their work attracted attention on the specialty circuit.

Art-house aficionados today might look back fondly to postwar times, when *Paisan* (U.S. release, 1948) could gross the equivalent of seven million current dollars and *I Know Where I'm Going!* (U.S. release, 1947) could play at a single Manhattan theatre for a year. The triumphant welcome given to films by Rossellini and de Sica allowed distributors to occasionally help finance new projects; Italian Neorealist production was partly an American initiative. A few overseas companies set up their own U.S. theatres to take advantage of the U.S. market.

As that market grew during the 1950s and early 1960s, fueled by the rise of international film festivals, outstanding entrepreneurs emerged on the American scene. Some of their firms, such as Janus and New Yorker, still operate today. Occasionally, art-house operators moved into distribution as well. Exhibitor-distributors Cinema 5 and New Yorker are the predecessors of IFC and Music Box.

Fairly soon, most distributors set up nontheatrical divisions to furnish films to the growing 16mm market of college courses and film societies.

The major studios had been watching with interest and in 1957 began financing films from overseas. Over the next decade Columbia funded films by Godard, Demy, Truffaut, and Rohmer. United Artists underwrote many French imports and a three-film string by Bergman, while MGM financed *Blow-Up*. This policy of investing in foreign cinema in order to secure U.S. distribution has been revived several times since, with studio "classics divisions" periodically coming into being and then dissolving. The heyday of such divisions, the 1980s, saw them widen their compass to include English-language independent cinema, a more reliable moneymaker than subtitled imports. Orion Classics, the major art-house distributor of the period, enjoyed great success, chiefly with *Platoon*, *The Silence of the Lambs*, and other fairly mainstream projects. Today Fox Searchlight, Focus, and Sony Classics maintain the tradition of studio subsidiaries devoted to foreign and indie product.

In the heyday of foreign imports, art-house programming could pay a little. Before the advent of videotape, you could make decent money showing Ealing comedies, Fellini, and Bergman films years after their initial release. But the market shrank, partly because Hollywood films now routinely provided the eroticism and edginess that audiences had found in foreign films. Imported films had once supplied up to seven percent of U.S. box-office receipts, but by the 1970s the figure was closer to two percent, a level that has continued more or less until today.

The golden era, Balio has shown, ended in the late 1960s, so its collapse can't be fairly blamed on the rise of the Lucas-Spielberg blockbusters. Still, the market has refused to die. It has survived cable and home video, which in the 1980s provided ancillary income that helped make up for the loss of 16mm nontheatrical bookings. Distributors began buying imports less for theatrical release than for the video rights, which could return good profits. A key example was Miramax, the central art-house/independent distributor of the 1980s, which eventually became a subsidiary of the Disney company. While Miramax favored English-language titles, its main competitor, Sony Pictures Classics, developed a strong identification with Almodóvar, Ang Lee, and other auteurs.

The same years saw the emergence of the ambitious art-house chain Landmark. It originated as the Parallax circuit in 1974 and made most of its theatres "calendar houses," running frequently changing bills of classic Hollywood, cult favorites, and foreign films old and new. These packages would be circulated around the chain. My city's former Landmark house, the Majestic, is now a music club, but it yields wonderful memories of double bills of Hawks and Ford films, as well as a Leone *Dollars* triple feature.

Landmark Theatres eventually came into the hands of Mark Cuban and Todd Wagner. In 2004 they brashly announced plans to produce films through Wagner's HDNet cable company, distribute them through his company Magnolia Pictures, and show them in Cuban's Landmark cinemas. Over fifty screens, they announced, would be converted to 4K digital projection. As of spring 2012, few screens in the chain had gone digital.

Beyond the big chains, many art-house theatres have moved away from private ownership. As theatres closed, fans of foreign and independent cinema began to realize that their legacy film culture was in danger. Cities and towns began turning art houses into not-for-profit entities, funded by foundations, private donations, and government agencies, such as arts councils. Russ Collins, organizer of the annual Sundance-supported Art House Convergence conference, has argued for embracing this trend.

> Most "new model" Art House cinemas are nonprofit organizations managed by professionals who are expert in community-based cinema programming, volunteer management and the solicitation of philanthropic support from local cinephiles and community mavens.

Collins points out that over the twentieth century, museums and the performing arts have moved toward nonprofit status. "It makes sense that if music has a range from very commercial to very subsidized, film should too. There are all kinds of movies, and there should be all kinds of outlets."

Saturation and platforming

For years art-house and mainstream theatres ran on two different clocks. Since the 1970s, a major studio film would open on several thousand screens at the same time. It would play the major 'plexes, and two or three weeks later it would open in subrun houses like the JEM in Harmony. After a brief pause, it would move to second-run houses before going to video.

By contrast, the typical art-house release would be "platformed." First it would open in a few theatres in the biggest markets, aiming

to get press coverage and favorable reviews. In the following weeks it would expand slowly to other markets. There might be only two or three prints. As the film finished its run in a major market, the print would be shipped to a secondary one, and it would gradually make its way across the country. Art-house titles needed to build audience awareness more slowly than the hit-and-run tactics of studio launches allowed.

Take, for example, *Tinker Tailor Soldier Spy*, a solid French-United Kingdom import released in America in early December 2011. Focus Features played it a week in four venues before expanding to twelve more theatres. For the next week it played 55 theatres, and in the following week two more were added. Then, on 6 January 2012, it "went wide" to 809 theatres nationwide. The timing was strategic. Competition from *Hugo* and *The Descendants* was tapering off, and *The Artist* had yet to expand. No other art product took advantage of *Tinker Tailor*'s January wide-release date, so the film gained great momentum.

The expansion, based on Oscar buzz and the anticipation fueled by the slow rollout, yielded the film's biggest weekend grosses, a total of $5.4 million. Later wide releases, such as *The Iron Lady* and *The Artist*, had to contend with *Tinker Tailor*'s strong showing and favorable word of mouth. As January and February wore on, *Tinker Tailor* left some screens and moved to others, and the overall number of venues tapered off. By late March it was a second-run title, playing on fewer than a hundred screens. It was still playing second-run in my town on 10 May—after the DVD had been released. It had been in the theatrical market for five months.

These alternative systems, saturation and platforming, worked well enough when 35mm prints were the vehicle. But today the art-house clock needs to be reset, because Hollywood's saturation strategy is becoming the norm. The more prosperous art houses realize the advantage of early openings. Their sophisticated clientele is reading the *New York Times,* watching cable television, and surfing the Net. These viewers are eager to see a film that is garnering critical praise. An art-house operator with DCI-compliant equipment can get the film sooner. Platforming becomes less necessary, although distributors may still prefer to let press and word of mouth percolate over weeks and months.

There's another sort of venue, midway between art-house and mass-market auditorium: the "smart house." Smart houses are screens in mainstream 'plexes that will show films that get good response in art-house runs. From December through April, several major chains played *The Descendants, My Week with Marilyn*, and the like. There are, Jack Foley of Focus estimates, between 250 and 500 smart-house screens in the country, and these were key to his adroit expansion of *Tinker Tailor*.

The 'plex business model supports this sort of crossover. With most art houses still depending on 35mm prints rolling out, smart houses benefit from access to Digital Cinema Packages, which can be sent out simultaneously. Typically a film starts in the core art-house venues and then expands to smart houses if it does well. But a smart house, backed by the muscle of a strong chain, might well be able to grab a digital copy earlier than a neighboring art-house venue. That turns the art-house into a subrun house or denies it the

title altogether. Moreover, an art-house with few screens can't hold a film very long; other things are coming that should be played. But a smart house in a 'plex can hold a crossover title long enough to milk it for full value while putting newer material on adjacent screens.

Where do they *get* those movies?

In such ways, the digital conversion has the potential to reshape traditional distribution strategies. It's also affecting programming. What will the art-house operator show? The death of 35mm has made a difference in what can be offered. Consider the options.

Older films in studio collections are central to repertory cinemas, and many art houses that depend on recent releases will schedule classics now and then. Yet studios have become reluctant to supply 35mm library prints; those have become much more precious items. If the film isn't on DCP, exhibitors may be told that they must pay to have a DCP made, or show a Blu-ray or a DVD. But some repertory cinemas are reluctant to screen on the low-resolution formats, and rarer and more obscure titles are unlikely to be available on commercial discs. Unhappily, the digital conversion may lessen repertory programming. Audiences that don't live in a town with an archive or cinematheque will have less chance to discover film history.

Art-house films distributed by studio subsidiaries are the tentpoles and blockbusters of this market. In the 2011-2012 season, art houses would have suffered grievously without *Tinker Tailor Soldier Spy* (Focus), *The Descendants* (Fox Searchlight), *A Dangerous*

Method and *The Skin I Live In* (Sony Pictures Classics), and *The Iron Lady, The Artist,* and *My Week with Marilyn* (The Weinstein Company).

Throughout 2012 the big art-house distributors were circulating prints. Jack Foley of Focus recognizes that film copies remain the default for most art houses. For Focus, 35mm circulation makes sense because many films play widely enough and roll out slowly enough to amortize print costs.

> Focus will be patient with its core customers and their financial challenges in going digital.…Supplying them with 35mm in the meantime allows us to play them and play them cheaply by using prints multiple times at no cost more than shipping.

But studio subsidiaries like Focus must also provide the DCI-compliant Digital Cinema Packages to the smart houses and the art houses that can play them.

At the moment, Foley points out, this split system is onerous for the art-house distributor because of the Virtual Print Fee. If a studio subsidiary like Focus supplies a film in the DCP format, it must pay the VPF. An $800 fee is a small fraction of a *Pirates of the Caribbean*'s income, but for an art-house title, it represents a bigger share of the revenue.

Other options are provided by smaller, independent distributors such as Kino Lorber, IFC, Magnolia, Strand, Roadside Attractions, Oscilloscope, and Zeitgeist. They circulate the most offbeat product, dramas like *The Messenger* and *Meek's Cutoff* (Oscilloscope) and documentaries and foreign titles like *Cave of Forgotten Dreams*,

Pina, and *Certified Copy* (IFC) and *13 Assassins* (Magnolia). Restorations and reissues of classics, such as *Metropolis* (Kino Lorber) and *On the Bowery* (Milestone), show up in this sector as well. These firms, like their studio counterparts, need the video aftermarket to support buying theatrical rights.

Most of these distributors currently offer releases on 35mm copies, but there are likely to be few of those. When a film isn't available on 35mm, a distributor may prepare a print if there's enough interest to help pay for it. But many venues will get the film sooner if they're willing to do a digital show.

Some indie distributors will supply DCP versions. But most Virtual Print Fee agreements demand that if a non-Majors film is to be played on a projector financed through the VPF, the independent distributor must chip in the fee. So distributors have pioneered other digital options.

The most popular alternatives to DCP have been Blu-ray and DVD versions. Virtually every art house is now projecting some first-run films on optical discs custom-made by the distributor. Music Box Films of Chicago made the Swedish version of *The Girl with the Dragon Tattoo* available on theatrical DVD, and the following films in the series were available on Blu-ray. For small screens, many exhibitors say, the disc format works fine and their patrons don't notice. Documentaries, especially those shot digitally, are particularly apt for Blu-ray, notes Clémence Taillandier of Zeitgeist.

A lateral option, sometimes called i- or e-cinema, also exists. There are now companies offering to deliver feature releases and alternative content via the Internet. Encrypted files, in HD, are

streamed to cinemas signed onto the system. Emerging Pictures, currently the dominant player in this domain, delivers material from many art-house distributors, including Sony Classics, IFC, and Magnolia. Other companies offering or preparing to offer comparable services are Specticast, Proludio, and Storming Images.

If an art house wants to show only films from the independent, second-tier distributors, then the pressure to convert to DCI isn't great. The exhibitor will, however, be playing many, perhaps most movies on DVD, Blu-ray, and streaming platforms. But the fact is that one *Iron Lady* pays for a lot of *Take Shelters* and *Uncle Boonmees*. The need to show art-house blockbusters will eventually push most operators toward obtaining the higher-end equipment. But that may put them in competition with multiplex-based smart houses.

Nibbling at the edges

Some major art houses have already converted. Film Forum in New York City, which mixes repertory and new releases, has long had a policy of showing classics on 16mm or 35mm film. Now the theatre is using DCPs; some restorations are not offered on film, and that trend is almost certain to grow.

Once a theatre converts, however, things don't necessarily get easier. For one thing, DCP playback makes exhibition less flexible. Shifting showtimes and screens is more difficult, as it may require special permission and a new digital key to open the file.

More constraints appear if the exhibitor funds the changeover through the Virtual Print Fee. As we've seen, VPFs oblige the exhibitor to screen only films supplied by the major companies—the

ones that created the standard. If an exhibitor wants to play an independent distributor's title on a DCP, that distributor needs to pay the fee, in effect helping to cover the theatre's conversion. Moreover, some art-house operators resent the air of surveillance that comes with playlist logs and Network Operations Centers. Experienced managers find them out of keeping with the more informal, trust-based atmosphere they've known.

There is evidence as well that some VPF deals prevent exhibitors from "splitting," that is showing two or more films in the same auditorium on one day. This is a practice that many art cinemas rely on because it allows them to vary programs during the sluggish middle of the week, or to compensate for having only one or two screens. With every show logged and perhaps also monitored by a NOC, splitting potentially becomes more difficult. Twentieth Century Fox has been militant on this front, sending a letter warning that theatres that practice splitting are in violation of contract and may be denied service by Fox or Fox Searchlight.

We've already seen that the smart houses in megaplexes discovered that they could make extra money with accessible indie or foreign fare. The same "art-house creep" is occurring in the realm of alternative content. The plays, ballets, and operas delivered by Web or satellite are a natural for art houses, but the big chains have discovered the niche. They realized that highbrow fare could pep up the barren stretch from Monday through Thursday. The theatre oligopoly was ready to oblige, with Fathom.

Fathom is a division of National Cinemedia. As noted in Chapter 3, NCM is owned by the three top chains (Regal, AMC, and Cin-

emark), and it's the biggest supplier of preshow advertising to the 'plex circuits. Using the same technology, Fathom sends standup comedy, pop concerts, operas, sports, and other material to screens via the Net. You're as likely to find Los Angeles Philharmonic concerts as sing-alongs with *The Sound of Music*, *West Side Story*, and *Dirty Dancing*. The shows play one or two nights, and they require advance ticket purchase, at heftier prices than feature films. Since NCM already has online digital access to over 17,000 screens in 47 states, it's as easy to fill the pipe with long-form entertainment as with twenty minutes of ads. In 2010, with access to the major circuits' houses, Fathom supplied about two-thirds of all U.S. alternative-content events.

Surprisingly, the most popular genre was opera, even though it commanded the highest ticket prices. "No one would have known that opera would be so huge," remarks John Fithian of NATO. "We are still struggling with the marketing barrier and letting people know the cinema is more than a movie house." Just as the independent purveyors of i-cinema will find it hard to compete with Fathom's penetration, the art houses hoping to flesh out their film offerings with doses of high culture may find the prime programs snapped up by the 'plexes.

One wing of art-house operators stresses the importance of the moviegoing experience. If you can't differentiate your offering by virtue of product—*Tinker Tailor* can be seen at a multiplex, at an art house, even on pirated downloads—you can do so through ambience and activities. Many art houses sell alcohol, and many others want to. Many offer more exotic food than the typical multiplex.

Some schedule special events, like annual midnight shows of *The Big Lebowski*. An atmosphere at once cozy and hip aims to distinguish the art-house experience. But even here the big chains are moving in. Megaplexes have expanded their concession menus and have begun to sponsor one-off fan events. As megaplexes customize the experience, perhaps to the point of offering beer and wine, they will again invade art-house territory.

Given the heavy-handed tactics of the major distributors, it's a relief to turn to the more idealistic independents. But business pressures have forced them to adopt policies that may nibble away at the business of their art-house clients. The stakes have been raised by Video on Demand.

The big studios have been anxious to expand their share of VOD and even push a "premium" version that would closely compete with 'plex release dates. But they haven't yet dared to risk exhibitors' wrath by releasing films on VOD head-to-head with the theatrical launch. For the moment, the studios are hesitant to collapse the post-theatrical windows.

Not so the independent distributors. Ancillary income from DVD has declined steeply, and VOD can help offset those losses. We seldom learn how much a VOD release earns, but *Margin Call,* which attracted $5.3 million theatrically, reportedly took in an estimated $4 to $5 million on VOD. This is a huge amount of money for an independent film. Moreover, streaming provides fast returns, while DVD income doesn't show up for many months. Consequently, independent distributors release many of their most desirable films on VOD simultaneously with or even before theatrical

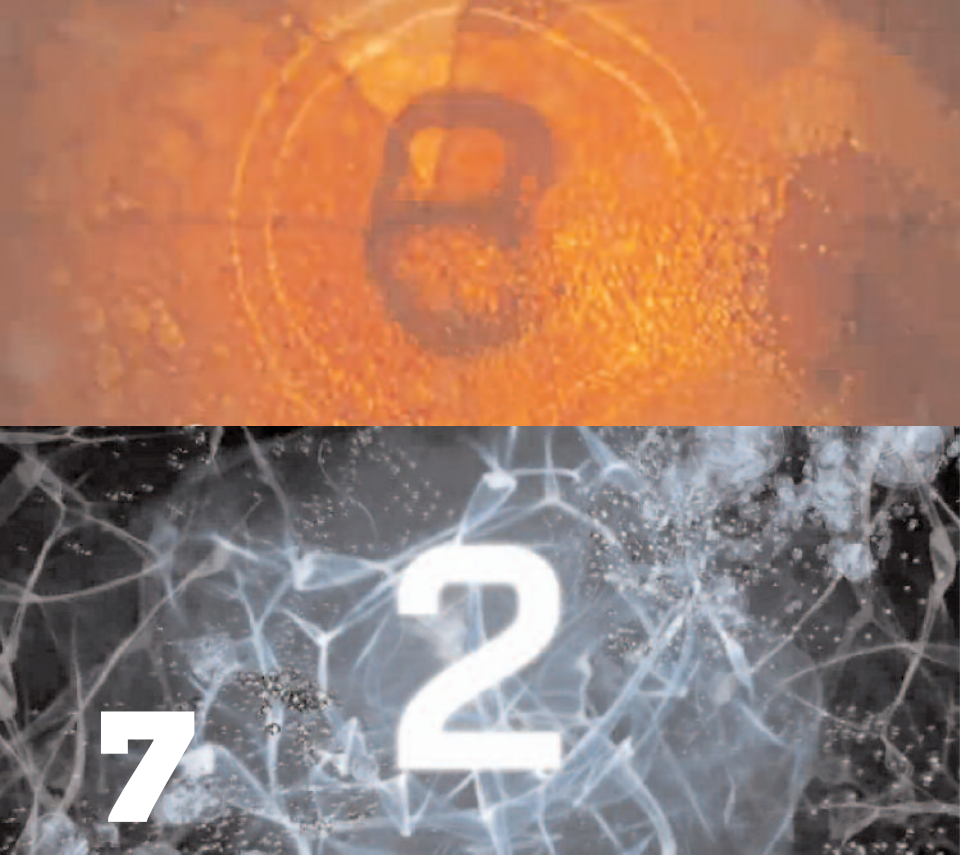
release. Magnolia put *Melancholia* on VOD several weeks before it was available at art houses.

Exhibitors cry foul. VOD, they suggest, is cannibalizing their audiences. Distributors reply that the theatrical and VOD audiences don't significantly overlap. For *Margin Call*, it's claimed, most people who saw it in the theatre didn't know that it was on VOD. Many who caught it on VOD would not have gone to a theatre. (It earned a good deal on pay-per-view in business hotels.) Distributors also point out that VOD reaches audiences in areas of the country that don't have art houses, so there's no danger of poaching there.

It's too soon to know how much early release on VOD can harm a film's theatrical release. Exhibitors are understandably nervous, though. Anything that might compete with their business threatens their small profit margins.

The art houses that survive the conversion to digital projection face a longer-term problem. The baby boomers, habitual filmgoers since the '60s, are likely to be around for just ten or fifteen more years. Where will new patrons come from? When I was in college, you scheduled your life around theatres' showtimes, but younger people have gotten used to time-shifting and immediate access. Even going to a video store is starting to seem like a chore, and outlets are closing anyhow, so why not stream or BitTorrent? A more worrisome sign: Juliet Goodfriend's survey reveals that even when art houses are near college campuses, students make up a small fraction of the audience. It's possible that changed tastes and a lifetime of unbridled access to movies will keep an aging Gen X from the art house.

Gary Palmucci of venerable distributor Kino Lorber recalls a line from Irvin Shapiro, who distributed foreign-language films for fifty years: "When were there ever *not* problems?" Martin McCaffrey, owner of Montgomery's Capri Theatre, says: "We're too small to die…and too stupid to quit."



Pandora at the Festival

Do you enjoy ads before movies? If so, there's fun in store for you. Besides all the commercials for cars, deodorants, and power drinks, you'll see promotions for the projector and the server and even the financing agent that supplied them.

One particularly aggressive curtain-raiser promotes Dolby servers. It starts with a ragged countdown leader (film is a dirty business) that snags and blisters in the gate. Photochemical imagery can't bear trial by fire and is annihilated *Terminator*-style. It explodes into sleek digitalia, alchemizing cinema into the four elements. Comfortingly, the flames are extinguished by earth (flowers), air (blue vapor) and icy water. McLuhan said film was a hot medium, but does that automatically make digital cool?

Take the clip as a victory dance. By September 2011, when I saw the Dolby Armageddon trailer at the Vancouver International Film Festival, things had already tipped. Digital projection, the immediate future for 'plexes, small-town houses, and art cinemas, has become a festival mainstay too. But the problems are more marked on the fest scene than in commercial venues. If you visit a festival and there's a hiccup during a screening, count to ten before hollering. The staff, already overstretched, is facing something far less tranquil than the refreshing final frames of the Dolby ad—something more like the blaze you see at the start.

The other distribution system

Both art houses and festivals are committed to an idea of alternative cinema—alternative, that is, to the mainstream commercial product of Hollywood. That's not to say that festivals won't show blockbusters occasionally. But these usually serve to lure big stars to the red carpet for a spray of glamour.

On the whole, festivals and art houses live off one another. Festivals gather films that might eventually be screened in specialty

theatres. Reciprocally, art houses promote their films as having won prizes or critical acclaim at festivals. No surprise, then, that art-house venues are often used for local festival screenings. In Milwaukee, Wisconsin, the Downer and the Oriental, classic houses now showing specialty films, are in heavy rotation for the city's ambitious annual festival.

Looked at more broadly, festivals play a different role in world film culture than art houses do. Art houses are a minority within a nation's system of commercial film exhibition. They may be run as not-for-profits in the United States, or receive government funding as in Europe, but they remain part of the national exhibition system. By contrast, film festivals function as part of an international network. That network forms a decentralized parallel to Hollywood's distribution system. As a result, festivals play unique roles, and they face unique difficulties.

The first annual festival we'd recognize as such was held in Venice in 1932, under the patronage of Mussolini's government. It was an international exposition, showing a diverse selection of titles from Hollywood, the USSR, Western and Eastern Europe, and even India and Japan. World War II brought the Venice festival to a halt, but it was revived in 1946. The prestigious Cannes festival launched that year, along with others in Locarno, Switzerland and Karlovy Vary, Czechoslovakia. Then came other festivals that are still with us: Edinburgh (launched in 1947), Berlin (1951), Melbourne (1952), San Sebastian and Sydney (1954), San Francisco and London (1957), Moscow and Barcelona (1959). In North America, festivals were created in New York, Los Angeles (known as Filmex),

Chicago, Denver, Telluride, and Montreal. By the early 1960s, a movie devotee could attend festivals year-round.

The upsurge in festivals after the war reflected the growing internationalization of cinema, the decline of the Hollywood studio system, and the expansion of independent filmmaking. Festivals helped define the public's conception of advanced cinema—at first centered in Europe, but later in other countries. Nearly all of today's revered non-Hollywood classics, from Italian Neorealism to the cinemas of the postcolonial world, can trace their fame back to triumphs at festivals. Festivals brought to attention the influential auteurs of the 1950s and 1960s, the new waves and young cinemas, and Third World political filmmaking. Virtually every major director or trend in art-house cinema achieved recognition at festivals.

Go back to *Uncle Boonmee Who Can Recall His Past Lives*, which earned a paltry $184,000 on the U.S. art-house market in 2011. That film would not probably not have found U.S. theatrical distribution had it not won the Palme d'Or, the top award at Cannes. Before that the director, Apichatpong Weerasethakul of Thailand, had attracted growing red-carpet acclaim. *Blissfully Yours* (2002) and *Tropical Malady* (2004) had won lesser prizes at earlier Cannes sessions, while *Syndromes and a Century* (2006) had been funded by a cultural festival in Vienna and attracted controversy because of the Thai government's attempts to ban it. Weerasethakul's remarkable works constitute only one reminder that if we didn't have festivals, we wouldn't have a film culture distinct from the infotainment world of Hollywood publicity.

Despite its role in promoting films for a world market, the festival circuit was still quite small before the 1980s. In 1981, there were around a hundred annual festivals. Twenty years later, there were over 700. By 2008, counting all the local and regional events, the world contained at least 4000 festivals. France held 350 annual events, and North America had over 1500. Toronto, a film-loving city par excellence, presents seventy festivals each year. Film festivals became a global distribution system, the only one rivaling Hollywood's in quantity and reach.

Festival prizes attracted distributors looking for art-house fare. Winning a prize gave a film an economic advantage, while the director, producer, and stars gained fame (and perhaps investment for their next ventures). Films that didn't win, or were screened "out of competition," could acquire international distribution as well.

Some festivals created a parallel set of market screenings, where projects of all sorts could be pitched and previewed. Had you gone to the Cannes Marché in 1983, you could have put in a bid on *Exterminator 2*, *House of the Long Shadows* (starring Christopher Lee and Desi Arnaz, Jr.), *Over the Brooklyn Bridge* (with Elliott Gould, Margaux Hemingway, and Sid Caesar), *Escape from Beyond* (in Wonder-Vision 3D), and *Baby Love* ("In 1958 she was 15 and just old enough…But she was also his best friend's little sister"). The temples of cinema welcomed moneychangers. One of the major trends of the 2000s was the growing number of markets and financing forums attached to festivals.

The great majority of festivals are purely local affairs. Some last two days, others two weeks. Some aim to celebrate regional film-

making, others to promote tourism and boost the local economy. There are niche festivals focused on documentaries, science fiction, fantasy, or children's films, as well as on themes of ethnic identity, religion, politics, and feminist and gay issues. An annual festival in Ghent, Belgium, is dedicated to film music, while San Francisco's Tranny Fest screens films about transgendered life. Two Italian festivals, one in Pordenone and another in Bologna, are built around rediscovered and restored films from early eras of film history. In Austin, the music festival South by Southwest has incorporated film screenings and has become a major showcase for independent and offbeat cinema.

By shuttling films around the world, the festival system gives remote audiences access to films that would otherwise never be shown in their town. But most festival films don't get distributed commercially outside their country of origin. There isn't room for them all in the market, and wide exposure on the festival circuit can convince distributors that the audience for a film has already peaked.

Worse, despite the publicity a film receives, showing it at festivals can't repay the costs of production. As critic Roger Ebert has pointed out: "A good film will play seventy festivals and then that's it. It never gets picked up by a distributor, and it never plays in any theaters, and the people who made the film are expected to pay for the shipping costs and to send over the press kits and maybe send in a star or a director." For all of their drawbacks, however, festivals large and small have remained the chief mechanism for choosing, from all the thousands of films made outside Hollywood, those that might find international audiences.

Screener savor

The number of festivals increased during the 1980s for many reasons. Worldwide production was rising, producers realized that festivals could help get their titles seen internationally, and marginal countries, especially in Asia, saw a way to promote their cultural identity. Another cause was the technology of home video. For filmmakers, the expense of making 16mm or 35mm prints for festival submission limited the number of events to which they could apply. In addition, there was the risk that a print would be damaged. Sending a VHS tape was cheaper and safer, and producers could ship copies to many festivals simultaneously. The development of DVD in the late 1990s only increased the possibilities, creating that now-familiar sight in any festival office: wobbly towers of DVD cases holding films that have been turned down.

Screeners, as these DVDs came to be known, began to serve other purposes. Once a film was accepted, its screener could be kept on file for the local press. Often local critics watch screeners, especially if they have to write a review in advance of the festival and they've missed a press screening. Programmers visiting from other festivals also borrow screeners because they usually can't see all the films they might want to investigate for their events.

Academy Award DVD screeners, sent out by producers to promote the film to voters, are often of excellent quality. Festival screeners look much shabbier, by design. Anything approaching the finished film in image quality will be bootlegged and land on the Net or on TV in some remote country. Burned to DVD-R, sometimes from a VHS tape, and often in the wrong ratio or

anamorphically squeezed, festival screeners are usually garnished with a watermark, either a distributor's logo or simply a timecode readout. Often the watermark burns out important areas of the image.

I can't imagine claiming to have seen the movie after watching the typical screener. Yet for journalists, nomadic warriors of the festival circuit, screeners are wampum. You can swap them for favors, or rarer screeners. Ripped to .mov files or copied to another DVD, they flow throughout the network despite the best efforts of the producers and festival coordinators. When you visit the festival video library, you can spot a film with good international prospects: It won't be available on a screener.

Despite their name, screeners aren't for screening. Only the most lethal emergency would force a programmer to project a screener to a paying audience. But screeners were the thin edge of the wedge opening festivals up to digital projection.

Over the 2000s, visitors noticed that more and more film festivals were becoming video festivals. That was partly, of course, because filmmakers were embracing new digital capture methods, and festival projection had to adapt. But often films that would traditionally have been shown on prints were projected on video. At installments of the Hong Kong International Film Festival, I saw many classics transferred to DigiBeta or Beta SP. The argument was that the archive had only one print and could not afford to make a viewing copy. The decision was understandable, but the quality suffered. Some repertory titles were even screened from commercial DVD. That was better than nothing—many Hong Kong films from

as recently as the 1990s have vanished on 35mm—but it attests to the fact that digital video was becoming taken for granted as an option.

As with most areas of digital media, physical copies will give way to streaming and online storage. Festivals will rely more on the Cloud. Already over seven thousand festivals are encouraging filmmakers to submit their work via the site Withoutabox. The service broadcasts calls for entries, standardizes entry forms, collects submission fees, digitizes presskits, and promises to eventually be able to make the film previewed by hundreds of festivals. Since Withoutabox is a walled garden, accessible only to filmmakers and festival staff, it could curtail traffic in screeners. Withoutabox is a division of the Internet Movie Database, itself owned by Amazon.com, which already has the capacity to stream films on demand. It probably won't be long before this service, or something like it, stores digital versions of films indefinitely and feeds them to festivals for immediate or subsequent showing.

Digitalis

Can a festival simply go its own way—refusing arcane digital formats, avoiding the DCI standards, and showing good old 35mm? No. *Melancholia*, *Certified Copy*, and other crossover art-house titles are likely to arrive on DCP rather than film. Just as these are the most sought-after art-house films, they are the backbone of festival ticket sales. The big festivals will have to follow the lead of Cannes, which in 2011 screened sixty percent of its titles in DCP.

The midsize and small festivals are further disadvantaged. Distributors and producers want their films to premiere at the highest-tier festivals, and the few 35mm prints that exist are reserved for the bigger events. As a result, programmers who want desirable titles are being nudged, or shoved, to digital. Peter Porter, Director of the Spokane International Film Festival, observes:

> While we will always hear "We can't premiere with you," more often have I been hearing, "If you will screen non-35, you can have the title." In any case, if I insisted on 35mm prints, I would have no film festival. Of the forty or so features that we will screen, my guess is that fewer than ten will even be available on 35mm.

So film festivals are constrained to go digital. But to what formats?

Festivals playing product from major companies will need to accommodate DCP. In addition, more and more independent filmmakers will offer their work in that format. They can have the encoding done professionally, or try out do-it-yourself software applications. Festival technicians report, however, that at present home-made DCPs can be unreliable, and some festivals demand backup versions on tape or film.

At the other end of the scale, a festival can consider showing DVD or Blu-ray. But these are not ideal options. On a large screen, the low resolution of a DVD is unsightly. Blu-ray discs, of course, look better, and if the player can be coordinated with a 2K projection system (rather than a home-theatre-level HD projector), well-produced Blu-ray discs can be quite acceptable. This is an option

used by some art-house theatres, and it will probably become more common for the festival scene.

Ultimately, however, DVD and Blu-ray aren't geared for professional work. For example, to prepare a show, projectionists need to cue up the disc and let it sit idle until showtime. Unfortunately, many DVD and Blu-ray players will go to sleep or revert to standby mode in as little as two minutes. In addition, many discs don't have the safeguards of professional-level media. They get scratched easily and may then skip or freeze up during playback. (The risk is especially keen with discs made by the filmmaker.) As a result, projectionists screening an optical disc will often have a second copy to hand on another player, running a minute or so behind, so that if the first one fails, the second can go on (and, one hopes, not fail).

For visual quality, the digital formats used in production are usually preferred for festival playback. Consumer/prosumer systems such as Mini DV and DV Cam are largely in decline, but at the professional level, there are several options, mostly provided by Sony. Betacam SP, an analog format, and Digital Betacam (aka DigiBeta) are still being used. They are, however, being surpassed by the success of HDCAM, another Sony device. Properly adjusted, HDCAM can yield HD images of 1920 x 1080 pixels, rather close in resolution to the 2K standard. This feature makes HDCAM a popular option for independent filmmakers. Another notch up is HDCAM SR. The SR format was initially designed for high-end special effects (bluescreen/greenscreen) and became allied with Panavision in the creation of the Genesis camera. SR is sometimes used for big-budget television programs.

Creating more confusion, many of these formats come in various flavors: PAL or NTSC, anamorphic or unsqueezed, progressive or interlaced, recent upgrade or older specs, settings for various frame rates, and on and on. And there are yet other recording and playback formats, such as HDV, DVCPro, and D5 HD. When talkies came in, perhaps there were as many competing sound systems floating around alongside the two studio standards. But back then, there weren't film festivals.

Format flare-ups

The first question that will be asked by a festival coordinator is: *How much is this going to cost?* When it comes to buying or renting high-end playback equipment, the answer isn't pretty. An all-purpose Betacam playback deck costs about $21,000. Higher-end systems are more expensive. A new HDCAM deck costs between $40,000 and $80,000—about as much as installing a DCI-compliant 2K projection system. An HDCAM SR playback deck goes for a mind-boggling $230,000, so rental is more feasible, but that can run $650 or more a day.

Even paying the price, one can wind up with the wrong deck for the movie. A movie on HDCAM, for instance, may be encoded to play back at any of six frame rates, and few HDCAM decks will handle all of them. A DigiBeta deck that will run only NTSC, the American video standard, is useless for a film encoded in PAL, the European standard.

Because of the multiplicity of formats and the costs involved, festivals must restrict what exhibition formats they will use. Here

are the playback formats listed in the submission requirements of some major festivals, as of late 2011:

Telluride: Only 35mm or DigiBeta.

Seattle: 35mm, 16mm, or HDCAM.

Toronto: 35mm, DCP, or HDCAM.

Sundance: 35mm, 16mm, HDCAM.

Chicago: 35mm, DCP, HDCAM, DigiBeta, Blu-ray.

Ann Arbor: 35mm, 16mm, Mini DV, or Beta SP.

Los Angeles: 35mm, 16mm, DCP, HDCAM, DigiBeta anamorphic.

Rotterdam: 35mm, 16mm, Betacam SP (PAL), DigiBeta (PAL), or DVCam.

Filmmakers who want to submit a digital movie to lots of festivals will sooner or later have to convert the original files to another format. Professional conversion is expensive, and low-budget filmmakers may be tempted to try it at home. If the filmmaker's transfer turns out to be dire, the festival may have to try converting the movie itself or revert to the film's original platform, which means bringing in other playback equipment on short notice.

Alexandra Cantin is Print Traffic Manager of the Palm Springs International Film Festival and a veteran projectionist at over forty festival events. She notes:

> Festivals have always been the bridge from the traditional to the latest, greatest technology and everything in between. Whatever the filmmaker could afford to finish on is what we have to work with. At times I have managed as many as thirteen formats.

Worse, several formats might be needed for a single screening. The festival trailer-and-sponsor reel will probably be on Blu-ray or HDCAM. The feature may be accompanied by a short, which can be on any number of formats. A program of short films may come in a bevy of formats.

Then there's juggling schedules and spaces. Commercial 'plexes usually run the same film in the same auditorium all day for a week or so. Festivals run many different films each day in a single venue, often for longer hours. Let's say that a given screen is used for five movies in a day, at 10 AM, 1 PM, 4 PM, 7 PM, and 10 PM. The schedule leaves very little time, at most half an hour, to test how a given film will play before its show starts. Of course, the film can be previewed days or weeks ahead of the screening—if it arrives in plenty of time. (Most don't.)

So projectionists, programmers, and technical staff are constantly juggling time slots, formats, and different auditoriums.

> *Can we play this HDCAM copy of* Dark Bohemian Days *on Screen 1?*
>
> *No, because the HDCAM decks are only in Theatre 2 and Theatre 4.*
>
> *But* Bohemian Days *is over two hours long, and all the other long films are in Theatres 2 and 4, so we don't have a slot available.*
>
> *We could move* Granny Was a Tranny*, which is on DigiBeta, from 2 to a smaller screen, but we expect a big crowd for that, and we'd shut people out. Anyhow Screen 1 won't have DigiBeta playback…*

Moreover, most festivals want to be flexible—adding screenings of popular titles, or substituting a film when another doesn't arrive. Multiple video formats make on-the-fly adjustments more difficult.

When you reflect on all the permutations of schedule, equipment, venues, formats, and staff assignments, it's rather miraculous that most festival screenings start on time and are well-projected.

DCP = Damn Cinephile Problems?

Faced with a plethora of digital formats, a festival might prefer to have one standard, and the most logical one is 2K projection from a DCP. 2011 was the first big dry run for 2K digital cinema at the major festivals, and the road proved rocky. Screenings were canceled or delayed by hours. Occasionally digital copies had to be replaced by DVDs or 35mm prints (coming to be known as "analog backups"). In correspondence with several programmers and consultants, I've garnered a sample of eye-opening DCP breakdowns.

Recall that the DCP, the set of files packed into that matte brick hard drive, is part of a larger digital environment. There's the projector. There's the server in the booth that stores the film, along with trailers and other material, and allows the operator to build playlists for the show. There's the Theatre Management System, an umbrella device that coordinates all the servers and projectors, along with lighting, curtains, and other aspects of presentation. There is as well the Key Delivery Message, which secretes the digital key. As a security device, the KDM will open only one movie on one server for a specified time period. If you want to play the same movie on a

different server or projector, or at a different time, you need a second KDM.

What could possibly go wrong?

Projector problems: At one festival, the only DCP-capable projector broke down and had to be replaced by one that was flown in. An entirely new set of KDMs had to be generated.

Server/projector mismatches: Vancouver International Film Festival Director Alan Franey explains what happened at his event.

> Christie Digital provided us with their best new projectors and Dolby provided us with their best new servers. Both Christie (in Ontario) and Dolby (in California) are sponsors of VIFF and give full attention to quality control and technical support. The problem was that the stuff was so new and improved that it didn't work, and no one knew why.…Since these two pieces of equipment had never interfaced before, there was unanticipated software incommunicability.

Alan indicates that once the software was amended, projector and server could communicate, but "it took expert technicians 48 hours (without much sleep) to figure that out."

DCP damage: Like all computer files, a DCP can be corrupted. Often a duplicate DCP is sent as a backup. But sometimes that's corrupted too.

Ingestion digestion: A server has only a certain capacity, say seven hours. Alan Franey: "Assayas's *Carlos* barely fit." Under festival conditions DCPs are constantly being loaded into the server ("ingested") and extracted from it ("dumped"). For a feature-length movie, this can take a few minutes, or an hour, or more, depending on the input device. Alexandra Cantin says: "Ingesting, dumping,

and reingesting are common. We are showing so many titles that server space becomes an issue."

KDM time intervals: The KDM's permissible play period may be too confining. Shelly Kraicer, a Chinese cinema expert who has programmed at many festivals, points out:

> A screening could be aborted because of time-zone issues. A KDM has a start and stop date. If it too closely fits the screening dates (and that seems like what's been happening), then a twelve-hour time zone offset (say, Asia to East Coast USA) can put the KDM off by one day, and it could refuse to play.

KDM/DCP matchups: Even multiplexes are finding problems getting the KDM to open the DCP, with projectionists having to phone companies to walk through the security steps. The problems are exacerbated with foreign titles on DCP. Alexandra Cantin again:

> What if the hard drive is coming from Poland and the KDM is being issued from a French lab that is closed for two weeks over Christmas? And the filmmaker is on location in the Philippines? This is a current real scenario.

Inflexibility of programming: The KDM, like the DCP, is optimized for commercial theatres playing the same movie on the same screen for many days or weeks. In a festival, KDMs create headaches because the staff members are shifting titles from house to house, projector to projector, sometimes with little advance notice. Shelly Kraicer notes:

> If you need to move a DCP film from Screen A to Screen B tomorrow, you need to urgently request from the distributor that a new KDM be

> generated and sent and tested in time. This often doesn't work. (Try doing it over a weekend.)

Alexandra Cantin agrees:

> If one wants to change venues in response to audience demand, that is usually not possible unless the DCP is unencrypted, there's sufficient time for ingestion, and there's a KDM that allows for it.

You can argue that all these problems are teething pains. Venues will acquire servers and projectors, staff will become adroit at handling DCPs and KDMs, software will get standardized and hardware will get more reliable. Then things will run smoothly. Still, what will it take to set things right for the time being? The February 2012 installment of the Berlin International Film Festival suggests one answer.

The Berlinale is one of the top three festivals, along with Cannes and Venice. (Proud Canadians would insist that Toronto is just as important, and in many ways it is; but it's not ranked as an A festival by FIAPF, the professional federation that decides such things.) And it's pretty hard to argue with Berlin's standing. Its prizes have made careers and propelled films into world film culture—*La Notte* (1961), *Alphaville* (1965), *The Wedding Banquet* (1993), *Offside* (2006), *Tuya's Marriage* (2007), and most recently, the Iranian Oscar winner *A Separation*.

In scale, Berlin is the largest public film festival in the world. Across ten wintry days in 2012, patrons racked up over half a million theatre visits. 2400 screenings were spread across fifty venues around the city, and each screen showed five programs a day. One

quarter of the screenings were on 35mm. Slightly more were on DCP, and everything else was on other video formats.

The organizers realized the threat of incompatibility, blocked KDM access, corrupted files, and the like. So the Berlinale went into total management mode. Eighty projectionists were trained for the grueling days ahead. The Fraunhofer Institute for Integrated Circuits agreed to test every DCP submitted. Just as important, a new technical infrastructure was created.

One of the festival's partners, Dolby—the firm whose promo showed us photographic film being blasted to flaming bits—fulfilled its promise on a grand scale. Dolby set up a network of thirty-seven servers, each with a capacity of 2.75 terabytes, along with several theatre management systems, each holding a hulking 24 terabytes. The principal supplier of projectors was Barco, which provided eleven machines for the festival's use.

Many venues used the standard DCP method or some playback deck. But in some cases, the film was not present in the booth. Colt Technology Services laid underground fiber-optic networks, "fat pipes" that would link the servers of twenty or so venues to a central office. Riding on a broadband connection of twelve gigabytes per second, films were fed directly to theatres. That process was overseen by forty-five technicians.

Put aside the vast costs of all this. (The festival claims its overall budget to be 19.5 million euros.) Put aside the clichés about German efficiency, though they seem completely accurate in this case. The upshot is that mobilizing forces on this scale is an admirable but somewhat scary response to the new situation—scary because

such a totalizing effort seems the most rational way to prevent all the mishaps I've itemized.

Now that the Berlinale's network is in place, it can be used for years. But few festivals could mount such an engineering feat. Doubtless small and mid-tier festivals will come up with cheaper and more flexible stratagems for dealing with digital. Perhaps a less stringently secured format will replace DCP for specialty situations. Or, as with Withoutabox, films will be stored in the Cloud. For non-DCP programs, maybe filmmakers can project straight from their laptops—although projectionists are wary about this option.

Still, I wonder. Why should we expect the digital churn to stop? How long before Berlin, and everyone else, has to upgrade?

35mm projection was never free of snafus. Viewers have always encountered bad splices, wrong aspect ratios, and reels run out of order. Yet the new problems are of a different kind. 35mm was stable as a format, however bollixed it could become in execution. Since about 1930, you bought a projector and you threaded the film into it and set your sound and ran your show. Now we're in an environment in which nothing can be considered stable in the long run, or even medium-term. Alan Franey suggests why:

> Everything we know about the constant rapid evolution of computers seems to suggest that we're in for rapid obsolescence, constant upgrades, and at showcases like VIFF, a lot of on-site beta testing.…We have every reason to fear a five-year replacement cycle. Robust, no; expensive, yes.

Such worries are being borne out already. As I write this, theatres outfitted with the projectors manufactured in the first phase of the DCI standard are being told they must prepare to acquire a "series two" machine made after January 2010. The series one projectors will not handle 4K files or advanced frame rates, and the machines cannot be upgraded. "At some point," writes one expert, "the studios will not distribute content to folks running series one systems." There are, in other words, more troubles ready to fly out of Pandora's box, and festivals will feel the sting of them even more acutely than commercial venues.

8

The Artworks Formerly Known as Prints

Dawson City, in the Yukon Territory of Canada, has fewer than two thousand people today, but in the 1890s tens of thousands passed through in search of gold. Movies came too, but the remoteness of the place made Dawson City the end of the line for most prints. Many were stored in the basement of the Carnegie Library. In 1929, an enterprising bank worker shifted them to an abandoned swimming pool. The films were stacked up, covered by planks, and encased in tightly packed earth. Buried in the permafrost, the prints wound up underneath an ice hockey rink.

In 1978, builders discovered the Dawson cache. Sam Kula, then an archivist at the National Archives of Canada, stored the films temporarily in an icehouse and began the painstaking process of checking each reel. The U.S. Library of Congress was brought in because most of the 507 reels discovered were American. Among the finds were a Harold Lloyd short, a great deal of news footage, and a rich array of serials starring heroines of the 1910s.

Wellington, New Zealand, was another terminus for American movies during the old days. In 2009, a film preservationist from the Academy of Motion Picture Arts and Sciences learned that the New Zealand Film Archive held a lode of Hollywood films. The collection includes Westerns and Christie comedies, along with John Ford's supposedly lost *Upstream* (1927). Several American archives have been involved in restoring the seventy-five titles selected for repatriation. The restored *Upstream* played in festivals and special screenings during 2010 and 2011.

Whatever the merits of the films revealed—literally unearthed, in the Dawson instance—discoveries like these are signs of hope. Who knows how much more of our film heritage remains to be rediscovered? For this reason, George Eastman House archivist Paolo Cherchi Usai prefers to list a film not as "lost" but rather as "not yet found."

Given such discoveries, the archivists will set to work creating usable and enduring versions. But today such a task is much harder. Soon most of the films we make and show will not exist on photochemical stock. They'll be digital files, and they need to be kept securely. But how?

Will today's typhoon of ones and zeroes rip away our analog past? Will there ever be a digital Dawson City, a stockpile of files of lost movies? It seems likely that digital projection has, in unintended and unexpected ways, put the history of film in jeopardy.

Digital restoration: A success story

> Of the tens of thousands of feature films produced worldwide in the silent era, approximately ten percent survive.
>
> Jan-Christopher Horak, Director,
> UCLA Film and Television Archive

The Majors and other production companies maintain their own archives of assets, housing both recent productions and the library of older titles. A studio-based archive aims to maintain the firm's investment in its property. In contrast stand the nonprofit archives—public ones like the Library of Congress or privately supported ones like Eastman House and the Museum of Modern Art. These and hundreds of smaller archives are charged with protecting images and sounds we've deemed of cultural value. Often studios deposit films of historical importance at nonprofit archives for safekeeping and backup. Some countries require by law that copies of films circulated there be deposited in the national archive. Both nonprofit and studio archives have done excellent work, but I'll be talking largely of the nonprofit ones, which often receive films by donation, deposit, purchase, or accident.

Archivists distinguish between *conserving* and *preserving*. You conserve a film by storing it safely in temperature- and humidity-

controlled vaults. You preserve it by cleaning and patching it, and if necessary transferring it to a more stable medium. *Restoration*, which is the archival task most visible to the film-loving public, goes further. It involves working to bring the film back to something like an original state.

Before the 1970s, archives conserved and preserved, but seldom restored. Archivists at public institutions balanced two duties: keeping films safe for the future and screening them for the public and researchers. Like art museums, archives guarded treasures while putting some of them on display.

Most often, archives preserved their material by making the best possible copies. A big part of the job was migrating films from one format to another. For example, some early American film companies copyrighted their product by submitting rolls of paper on which each frame of film had been printed. These "paper prints" had to be transferred, frame by frame, to motion-picture film. Likewise, films surviving only in rare formats, like 9.5mm, 22mm, and 28mm, had to be transferred to 35mm so they could be run on standard equipment. Tinted films on nitrate were reprinted on black and white safety film. 16mm films might be blown up to 35mm, and 35mm might be reduced to 16mm for circulation to schools, libraries, and film clubs.

Most famously, thousands of films in archive collections exist on nitrate stock. That was the professional standard before 1950 or so, when the industry abandoned it. Not only did nitrate film have a habit of exploding or catching fire, but it tended to decompose. Experimental filmmakers have found a sinister beauty in decaying

footage, but archivists sought funding to help transfer their collections to acetate. Then archivists learned that some acetate prints degenerated into a vinegary, contagious vapor. So migration to a new, polyester-based stock became necessary.

Preservation, simply keeping films alive in long-lasting formats, was archives' central mission. In the 1970s a number of archivists also began restoring films. For example, most silent feature films were released in tinted and toned prints, but many copies survived only in black-and white. Restorers, guided by surviving paper records, aimed to create prints that approximated the original color schemes.

Restorers naturally faced decisions about what would count as an original. In 1989 there were six different versions of *Mr. Smith Goes to Washington*, running from 119 minutes to 132 minutes. In such cases, records of running times and postproduction work helped identify what was missing. If the footage couldn't be found, still photos or even a blank screen might cover the gaps, as in restorations of *Greed* and the 1954 *A Star Is Born*. An original musical score helped researchers measure how much footage from the original *Metropolis* remained to be found.

With the rise of cable television and home video, studios' film libraries became more valuable. Ted Turner, owner of the MGM, Warner, and RKO libraries, was blamed for "colorizing" some classics for his cable channels, but at the same time he invested in restoring a great many of them. Other firms followed suit. *Gone with the Wind* and Disney perennials were reworked for cable and VHS release.

The 1980s and 1990s became the great age of restorations. Audiences were reintroduced to *Napoléon*, *Becky Sharp*, *Lawrence of Arabia*, and *Vertigo*. Most of the era's restorations were driven by the television and video market. Kevin Brownlow and David Gill, working with Thames Television, reissued silent classics, with new scores by Carl Davis. Today Turner Classic Movies is our great display case for studio and off-Hollywood restorations; it's the closest thing we have to a Citizen's Film Library.

For decades, restoration has been a photochemical affair. Every major archive employed experts in rephotography and lab work who knew how to optimize the look of a print. Archivists like Noël Desmet of Brussels collected information about properties of film stocks and tinting dyes. Faded films could be reprinted through filters that might bring back some of the old snap. The look of old films was much improved by wet-gate printing, which bathed the frames in a liquid that masked scratches.

But not much could be done about the blotchy nitrate decay that might invade a scene, or the dirt and dust that earlier copies of the film bequeathed to the current one. And those films for which no original negative could be found, including *Citizen Kane* and *Singin' in the Rain*, would always be seen as the shadow of a shadow—new copies pulled from earlier, perhaps shabby ones.

The upside was that as long as you kept your source prints and your restorations on 35mm film stock in a cool, dry place, you had material that would last over a hundred years. Some day you might find better tools for improving what you had.

That day came fairly soon. The Disney company had a steady income from theatrical and video rereleases of its animation classics, and a 1990 reissue of *Fantasia* employed some video-paint work to correct flaws in the frames. *Snow White and the Seven Dwarfs* was then given high-resolution treatment. Dust-busting and color adjustments were made frame by frame. Re-released in 1993, *Snow White* was the first feature to be restored digitally.

Since then, digital fixups have become a standard method for archival restoration. Footage is scanned into a file at 2K or 4K resolution. Either manually or automatically, the software can stabilize jumpy or shaky imagery, erase dust and scratches, and balance exposure, contrast, and other factors. It can interpolate image areas in order to correct damages in the frame, and it can add tinting or toning. The finished files may then be saved as files or scanned back onto film, as *Snow White* was.

Very soon most restorations are likely to be finished and screened on digital formats, with virtually no 35mm prints circulating.

Born-digital, born-again digital?

> The preservation of born-digital films is going to be the greatest challenge ever to face archivists.
>
> Margaret Bodde, Executive Director of the Film Foundation

The new magical software has sometimes led to overrestoration. Grain has too often been polished out, creating a plastic sheen. Still, today no archivist can avoid using the new toolkit. The sadder story involves not restoration but conservation and preservation. A civil-

ian might think: *That's simple. Just save film on film and digital on digital.* But things are more complicated than that.

Let's go back to the *The Girl with the Dragon Tattoo*, which was shot with digital capture. After it was finished, a master copy, or Digital Source Master, was prepared. That's like the original negative of a photographically based film. Then came the Digital Cinema Distribution Master, unencrypted and uncompressed. Then the DCDM was compressed and became a set of files on the Digital Cinema Package. After the theatrical runs and a short interval, *The Girl* showed up on DVD, Blu-ray, cable Pay Per View, Web streaming, and other platforms.

The source master, the distribution master, and the DCP are housed in studio libraries, along with 35mm copies. Many studio films are housed in other archives too, until recently as 35mm copies. But what will those institutions now keep? Overseas archives may receive DCDM files from local filmmakers, and American archives might get them from independent companies. But no U. S. studios will give archives unencrypted files, so the only feasible formats for major releases are 35mm and the DCP.

Suppose your film archive is lucky enough to receive both a DCP and a 35mm print of *The Girl*. Pick up that brick that is the DCP. How do you gain access to the movie, the "essence" files?

A DCP is typically encrypted to block piracy. When *The Girl* played theatres digitally, each exhibitor was provided the Key Delivery Message containing an alphanumeric password that would open the files for loading into the theatre's server. By the time you

the archivist get the files, that KDM may have expired or been lost. Without the key, the DCP is useless.

Then there's the matter of storage. The 35mm print of *The Girl* can simply be passively conserved, following the motto, "Store and ignore." But all digital material, no matter how minor, requires proactive preservation. The future for digital storage is constant migration.

Archivists estimate the life of any digital platform to be less than ten years, sometimes less than five. All hard drives fail sooner or later, and they need to be run periodically to lubricate themselves. Tape degradation can be quite quick; one expert found that forty percent of tapes from digital intermediate houses had missing frames or corrupted data. Most of the tapes were only nine months old.

Moreover, hardware and software are constantly changing. One archivist estimates that over one hundred video playback systems have come and gone. Archives currently recognize over two dozen video formats and over a dozen audio ones.

Periodically, then, the DCP files of *The Girl* will have to be checked for corruption and transferred to another tape or hard drive, and eventually to another digital format. Such maintenance takes time; shifting a terabyte of data from one system to another demands at least three or four hours. Ideally, you'd want several copies for backup, and you'd want to store them in different locations.

There are hundreds of other films like *The Girl* awaiting processing at major archives. About 600 to 900 feature films are produced in the U.S. each year. Currently the world is producing about 5500

features per year. At some point, they will all originate in digital capture.

Besides access and storage there's the matter of cost. Storing 4K digital masters costs about 11 times as much as storing a film master. You can store the digital master for about $12,000 per year, while the film master averages about $1,100.

How do the overall costs of digitizing mount up? Look at the situation in Europe. It's a remarkable fact that the European Union countries produce about 1100 features and 1400 shorts per year. (Who watches them?) An EU archival commission, the Digital Agenda for European Film Heritage, estimates that to conserve one year's output would require 5.8 PB (petabytes) of storage. In 2015, the costs of archiving that year's output (without restoration) are projected to be between 1.5 million and 3 million euros. Beyond initial conservation, long-term preservation of that single year's output would consume, though migration and backing up, about 1900 PB and cost about 290 million euros.

The access problem is soluble. Your archive could be given an unencrypted DCP of *The Girl* and then create its own key to prevent copying. Or the DCP could be assigned a generic key, perhaps for a specified time period, that will open the files in a secure milieu. The files could then be migrated to a format under archive control. On the matter of software, archivists are working on establishing standard preservation file formats and codecs. To deal with the other problems, you'd have to press for increased budgets and personnel. Those costs, including training staff on ever-changing platforms, are of tidal-wave proportions.

Photochemical Armageddon?

> The methods we have for securely storing comprehensible digital data are highly labour-intensive. Humans are too slow and they cost too much.
>
> Bruce Sterling, science-fiction writer

So why don't you preserve *The Girl*'s DCP files on film? Film is universally recognized as the most stable platform for moving-image material. Properly stored, a film print can last a hundred years or more. Maintaining a print, as we've seen, is cheaper than maintaining digital files. It's significant that the archives of most of the major studios continue to transfer all their current features to film.

There are drawbacks to this as well. For one thing, no 35mm system can preserve the uncompressed sound that is held on a DCP file. More drastically, the costs of making a file-to-film transfer can run to tens of thousands of dollars.

In the long term, the problem is legacy equipment and skills. The same forces that squeezed out 35mm production and projection have hurt 35mm preservation too. The equipment and material for outputting digital files onto film will eventually cease to be available. With the rise of digital projection, demand for film stock plummeted. Eastman Kodak's 2012 bankruptcy filing reflects the declining market for raw film, and even though Fuji promises to continue to make 35mm stock, it is likely to get more expensive. As David Hancock of *IHS Screen Digest* points out, the cost of silver, a necessary component of raw stock, is rising steeply after being low for many years.

Sensing a niche market, Kodak has announced that it will provide a new emulsion favorable to archival preservation. But at the moment, laboratories that can process and print film stock are closing. Not for nothing does Nicola Mazzanti, Director of the Royal Film Archive of Belgium, suggest with a straight face that an archive should consider buying a lab.

Anyhow, preserving on film may simply postpone Armageddon. The most recent European report of the Digital Agenda for European Film Heritage concludes:

> As a solution [digital migration to film] will only be viable as long as the analogue film 'ecosystem' (equipment, film stock, laboratories) exists. Instead of being a long-term solution, the risk is that it becomes a very short term one. In the long term it will make problems worse as it will increase the number of works that need to be digitised in the future.…At 25,000 euros to 100,000 euros per feature film, the going-back-to-film solution appears to be 20 to 80 times more expensive than digital preservation.

If preserving on film is increasingly unlikely, how about preserving on digital formats? Perverse as it sounds, can you take your 35mm print of *The Girl with the Dragon Tattoo* and store it as tape or files? Yes. This is called "digital reformatting." Once film has been scanned, archives can make DCPs at low cost. But the initial scanning is costly, and high-end 35mm scanners, though still in use to make Digital Intermediates for 35mm releases, are likely to be costly for nonprofit archives. In any event, saving film digitally puts us back to the problems of digital conservation and preservation:

cost, storage, maintenance, and access. (Surely the rights holders will want the archive to encrypt its homemade DCPs.)

It's hard to get your mind around the scale of the problem. Here is Ken Weissman of the Library of Congress:

> Speaking very broadly, with 4K scans of color films you wind up in the neighborhood of 128 MB per frame.…Figure that a typical motion picture has about 160,000 frames, and you wind up with around 24 TB per film. And that's just the raw data. Now you process it to do things like removing dust, tears, and other digital restoration work. Each of those develops additional data streams and data files. We've decided, based upon our previous experience, that it is best to save the initial scans as well as the final processed files for the long term. Now we are up to 48 TB per film. In our nitrate collection alone, we have well over 30,000 titles. 48 TB x 30,000 = 1,440,000 TB or 1.44 EB (exabytes) of data.

Weissman adds with a trace of grim humor: "And of course you want to have a backup copy."

The girl with the photochemical tattoo

> I think that film-on-film projection will ultimately become the sole purview of archives and museums.
>
> Michael Pogorzelski, Director of the Academy of Motion Picture Arts and Sciences Film Archive

Once you've found a way to conserve-preserve *The Girl with the Dragon Tattoo*, what if you want to show it tomorrow? Or ten years from now? Or fifty?

If you have a DCP in good shape, and a projector that will show 2K/4K according to the Digital Cinema Initiatives standard, you're good to go. For now. But maybe not tomorrow.

After the projector/server market is saturated and everybody has DCI-compliant equipment, equipment manufacturers and software designers have to keep innovating to sell new machines. Many observers expect the D-cinema standard to be recast in the next ten to fifteen years, and projectors may be redesigned sooner than that. Mazzanti anticipates that there will be 8K resolution, greater bit depths, faster frame rates, laser projection, new sound formats, and other advances. Already innovations are leapfrogging DCI standards: a new generation of projectors is threatening to make earlier models obsolete. If you program your digital version of *The Girl* for its twenty-fifth anniversary in 2036, you will probably have to reformat it for whatever your projector can then play.

So instead you hold on to your 35mm print. That will give you cachet, because within a decade all commercial cinemas will be digital, and, as Mike Pogorzelski mentions, only archives will show 35mm. But cachet takes cash. Archives, at least the major ones, will have to retain their 35mm inspection and projection gear, even though that will probably cease to be made and parts will be cannibalized. You'll need vigilant, resourceful staff who know how to fix old machines.

Moreover, with the scarcity of raw stock and the shuttering of laboratories, archives will be less likely to make screening copies of their holdings. Virtually every 35mm copy the archivist holds, from *Red Desert* to a Bowery Boys movie, becomes irreplaceable, what

Mazzanti calls a "unique master." Then film archives will truly become film museums, custodians of extremely rare artifacts.

At some point no one may risk running analog film, as the damage would be irreparable. In that worst-case scenario, archives will show digital copies, either derived from prints or supplied by whatever sources they can find (including, yes, Blu-ray or whatever comes after). One consequence may be the freezing of the canon. We'll get more and better versions of old standbys like *Metropolis* and *Napoléon*, but less effort to retrieve lost or ignored items from scratch. New discoveries may simply be too expensive to maintain, especially if they lack the crowd-pleasing appeal of the most famous classics.

I biased the case by taking as typical a major studio production like *The Girl*. What about the hundreds of independently made shorts and features? I'm thinking of documentaries, DIY features, animated shorts, and experimental works. Each was made on whatever video or film format the filmmaker could find or could afford, and it was finished with almost no thought of how it would be preserved. The Science and Technology Council of the Academy recently published its second comprehensive study of "the digital dilemma" and were surprised that most of the independent filmmakers they interviewed were unaware of how perishable their work was. Says Milt Shefter, an author of the report:

> They were concentrating on the benefits of the digital workflow, but weren't thinking about what happens to their [digital] masters. They're structured to make their movie, get it in front of an audience, and then move onto the next one.

Still more unaware, I imagine, are all the people making amateur footage. Louis Lumière's *La Petite fille et son chat*, a sort of home movie of his daughter teasing the family pet, was made on film in 1900. It is still around to charm us. The YouTube adventures of Maru, a LOLcat superstar, aren't likely to last so long.

Adroit archivists are trying to come to grips with these problems, and I'm sure they'll make some headway. These are people of expertise, good will, and obstinate idealism. As far as I can see, they're somewhat divided at the moment. Some favor moving into digital preservation immediately, since that's going to be inevitable at some point. Others suggest staying with film as long as possible. When the inevitable comes, the archive would preserve films and their associated technology as historical artifacts, somewhat like Japanese *ukiyo-e* prints or Fabergé eggs. Alexander Horwath of Vienna's Filmmuseum writes:

> The museum is not the worst place to end up, quite the opposite. Even in the most "unthinking" museum, the strange material shape of the

> artifact reminds visitors of alternative forms of social and cultural organisation and, therefore, that the currently dominant forms and norms are not the only ones imaginable: forms and norms are never "natural", but historical and man-made.…Today, the expression *'You're history!'* is meant as an insult, not as a factual statement. Isn't it essential, therefore, to side with those so insulted in order to keep alive any notion of historicity?

I'm not equipped to weigh in on this professional dispute. For my part, I'm hoping that curious cinephiles will recognize what has happened under our noses in just a few years, and that we'll sense the enormity of what archives face.

The digital gold rush, along with fear of piracy, favored short-term solutions and proprietary, incompatible software and hardware. There were too many ephemeral video formats chasing the consumer and prosumer market, with little thought of how those formats would be preserved. The days of 8mm, super-8mm, 16mm, 35mm, and 65/70mm were simple by comparison. We're left with a plethora of transitory standards that will be impossible to recover. Not-for-profit archives will struggle to maintain collections with any thoroughness. Choosing what to save, always necessary, will now become crucial. Only a fraction of what we have can be conserved—not preserved, merely *kept*.

And future discoveries of lost films? I asked Chris Horak of UCLA to imagine a scenario in which a cache of digital movies has been discovered in an obscure spot, permafrost or no permafrost. He answered:

> If I found a reel of 35mm film in 500 years and didn't know what it was, I could probably without too much trouble figure out a way to reverse-engineer a projector. In any case, I can always look at the individual frames, even without a projector, and see what is there.
>
> If I find a cache of Blu-rays and DCPs in 500 years, what do I have? Plastic waste. How do you reverse-engineer those media? Impossible. Without an understanding of the software and the hardware, you have zip. No way to look at it, no way to know even if it has any information on it.

Brussels curator Nicola Mazzanti entitled his penetrating overview of the digital conversion simply and apocalyptically: "Goodbye, Dawson City, Goodbye."

Conclusion

Churn

It wasn't originally a box but a jug. And it might not have been filled with all the world's misfortunes; it might have held all the virtues. In Greek mythology, the gods created Pandora as the first woman, sort of the ancient Eve.

We get our standard idea of her story not from the ancient world, however, but from Erasmus. In 1508 he wrote of her as the most favored maiden, granted beauty, intelligence, and eloquence.

Hence one interpretation of her name: "all-gifted." But to Prometheus she brought a box carrying, Erasmus asserted, "every kind of calamity." Prometheus' brother Epimetheus accepted the box, and either he or Pandora opened it, "so that all the evils flew out." All that remained inside was Hope. (Don't think there isn't a lot of dispute about why Hope was cooped up with all those evils.)

The idea of Pandora's box spread throughout Western culture to denote any imprudent unleashing of a multitude of unhappy consequences. It's long been associated with an image of an attractive but destructive woman, and we don't lack examples in films from Pabst to Lewin. But there's another interpretation of the maiden's name: not "all-gifted" but "all-giver." According to this line, Pandora is a kind of earth goddess. In one Greek text she is called "the earth, because she bestows all things necessary for life."

The less-known interpretation seems to dominate in James Cameron's *Avatar*. Pandora, a moon of the huge planet Polyphemus, is a lush ecosystem in which the humanoid Na'vi live in harmony with the vegetation and the lower animals they tame or hunt. Nourished by a massive tree (they are the ultimate tree-huggers), they have a balanced tribal-clan economy. Their spiritual harmony is encapsulated in the beautiful huntress Neytiri. As the mate for the first Sky-Person-turned-Na'vi, Avatar Jake, she's also an interplanetary Eve. When Jake joins the Na'vi on Pandora, he does find hope.

The irony of the super-sophisticated technology carrying a modern man to a primal state goes back at least as far as Wells' Time Machine. But the motif has a special punch in the context of the Great Digital Changeover.

Digital projection promises to carry the essence of cinema to us: the movie freed from its material confines. Dirty, scratched, and faded film coiled onto warped reels, varying unpredictably from show to show (new dust, new splices), is now shucked off like a husk. In the Dolby trailer, images and sounds bloom in all their purity. The movie emerges butterfly-like, leaving the marks of grimy machines and human toil behind. As Jake returns to Eden, so does cinema.

Kristin Thompson suggested the title for the blog entries on which this book is based. The allusion seemed right for several reasons. For one thing, *Avatar* was a turning point in digital projection. 3D, as we now know, was the Trojan Horse that gave exhibitors a rationale to convert to digital. *Avatar*, an overwhelming merger of digital filmmaking and 3D digital projection, fulfilled the promise of the mid-2000s.

With its record $2.7 billion worldwide box office, *Avatar* convinced exhibitors that digital and 3D could be huge moneymakers. In 2009, about 16,000 theatres worldwide were digital; in 2010, after *Avatar*, the number jumped to 36,000. True, U.S. chains also benefited from JP Morgan's timely infusion of about half a billion dollars in financing in November, a month before the film's release. Still, this movie that criticized technology accelerated the appearance of a new technology.

Throughout those blog entries and this book, I've tried to bring historical analysis to bear on the nature of the change. Let's total up the gains and the losses.

The cash cow

Over the last ten years, the income from commercial cinema has exploded. In 2010, global box office was estimated at $31.8 billion, nearly twice that of 2000 and an all-time high. Digital projection doesn't seem on its own to have attracted a significant increase in admissions—worldwide, total admissions annually stay flat or decline a bit—but it has raised revenues. (That's not to say that it has raised profits; over the same period, movies have gotten more expensive to make.)

Annual North American box office revenues have risen from about $9 billion in 2004–2005 to over $10 billion in 2009–2011. According to the Motion Picture Association of America's reckoning, between $1 and $2 billion of that $10 billion is traceable to the extra charge levied for tickets to 3D movies. That calculation probably overstates the contribution of the stereoscopic format, but there's no doubt that the surcharge contributed something to keep the revenue up.

The biggest growth was overseas. Two thirds of international box office in 2010 came from outside North America. All regions had been surging since 2005, when the digital push began in earnest, and Russia and China yielded spectacular returns. With $1.5 billion in ticket sales, China elbowed its way into the world's top five markets. A good deal of the growth came from replacing old screens with modern, all-digital ones in Central and Eastern Europe, Central and South America, Russia, and China. The 3D format contributed to the rise, as did the giant screens of Imax, two-thirds of which are digital. China and Russia are currently the

fastest-growing markets for these megascreens. Imax plans 200 installations in China over the next few years.

The move toward multiplexes was already under way in these emerging markets, where the middle class was expanding, and digital projection fitted nicely into that business plan. Newly affluent patrons were ready to enjoy movies American-style—in comfortable seats, on big screens, with popcorn bucket in hand and 3D glasses perched dutifully on their noses. And what they mostly wanted to see were American movies.

We may never know just how much money digital projection has saved distributors, but the amount is very substantial. Preparing a Digital Cinema Package is much cheaper than processing a 35mm print, and the DCP drives can be reused. As for exhibitors, despite the heavy price tag, digital projection has allowed them to cut some operating costs. Meanwhile, the Big Three chains have expanded their business by going into distribution themselves, through the delivery of preshow attractions and alternative content such as plays and operas.

In addition, digital cinema in its higher-end formats has raised standards of presentation in many parts of the world. Even 1.3K projection is preferable in image and sound quality to what thousands of venues were giving their audiences on film. As I've argued earlier, it's probably superior to what most American small-town venues were providing during those days that nostalgic cinephiles fondly recall. In my youth I saw enough washed-out drive-in movies with sound delivered through a tinny speaker, and enough

shabby 16mm prints in film clubs, to have some sense of what film projection must be like in remote corners of the earth.

But there's no denying as well that Pandora's digital box unleashed a lot of problems. From multiplexes to art houses, from festivals to archives, the new technical standards and business policies have created an upheaval in film culture. Hollywood distribution companies have gained more power, local exhibitors have lost some control, and the range of films that find theatrical screening is likely to shrink. Movies, whether made on film or digital platforms, have fewer chances of surviving for future viewers. Sectors of our film heritage that are already peripheral—current foreign-language films, experimental cinema, topical and personal documentaries, classic cinema that can't be packaged as an event—may move even further to the margins.

Moreover, as many as 8,000 of America's 40,000 screens may close. Their owners will not be able to afford the conversion to digital. Creative destruction, some will call it, playing down the intangible assets that community cinemas offer. There's also the obsolescence issue. Equipment installed today and paid for tomorrow may well turn moribund the day after tomorrow. Only the permanently well-funded can keep up with the digital churn, and there's no reason to think that the major distributors and the Internet service providers will be feeling generous to small venues.

The sharper image

> A Pixar movie is just a very large number, sitting idle on a disc.
>
> George Dyson

Cinephiles will mention another loss: the look and feel of photochemical film. What is the difference between digital projection and 35mm projection?

First, let's remember: it's not *digital projection vs. celluloid projection*. 35mm motion picture release prints haven't had a celluloid base for about fifteen years. Release prints are on mylar, a polyester-based medium.

Mylar was originally used for audio tape and other plastic products. For release prints of movies, it's thinner than acetate but it's a lot tougher. If it gets jammed up in a projector, it's more likely to break the equipment than be torn up. It's also more heat-resistant, and so able to take the intensity of the xenon lamps that became common in multiplexes. (As we've seen, many changes in projection technology were driven by the rise of multiplexes, which demanded that one operator, or even unskilled staff, could handle several screens.)

But acetate-based film stock is still used in shooting films, so I suppose *digital vs. celluloid* captures the difference if you're talking about production. Even then, though, there's a more radical difference. A strip of film stock creates a string of images that we can hold up to the light and study directly. Video creates an array of pixels that can only be accessed through a monitor. And a digital image is simply an abstract configuration of ones and zeroes existing in that intangible entity we call, for simple analogy, a file.

Even the d-word obscures an important point. Not so long ago, the difference was pitched as *film versus video*. That was the era of movies like *The Celebration* and *Chuck and Buck*. Then came *high-*

definition video, which was still video but looked somewhat better (though not like film). But somehow, as if by magic, very-high-definition video, with some ability to mimic photochemical imagery, became *digital cinema*, or simply *digital*.

So what is the elusive "film look"? I'm far from offering a complete definition. There are many film looks. You have orthochromatic and panchromatic black-and-white, nitrate vs. acetate vs. mylar, two-color and three-color Technicolor, Eastman vs. Fuji, and so on. But let's stick just with projection. Is there a general quality of film projection that differentiates it from digital displays?

Some argue that flicker and the slight weaving of film in the projector are characteristic of the medium. Others point to qualities specific to photochemistry. Film has a greater color range than digital media: billions of color shades rather than millions. Resolution is also different, although there's a lot of disagreement about how different. A 35mm color negative film is said to approximate about 7000 lines of resolution, but by the time a color print is made, the display yields about 5000 lines—still a bit ahead of 4K digital. But each format has some blind spots. There's a story that the 70mm camera negative of *The Sound of Music* recorded a wayward hair sticking straight up from Julie Andrew's head. It wasn't apparent in release prints of the day, but a 4K scan of the negative revealed it.

Film fans point to the characteristic film shimmer, the sense that even static objects have a little bit of life to them. Roger Ebert writes:

> Film carries more color and tone gradations than the eye can perceive. It has characteristics such as a nearly imperceptible jiggle that I suspect makes deep areas of my brain more active in interpreting it. Those

characteristics somehow make the movie seem to be *going on* instead of simply *existing*.

Watch fluffy clouds or a distant forest in a digital display, and you'll see them hang there, dead as a postcard vista. In a film, clouds and trees pulsate and shift a little. Partly the film is capturing very slight movements of them in air, or the movement of light and air around them. In addition, the film itself endows them with that "nearly imperceptible jiggle" that our visual system detects.

How so? Brian McKernan points out that the fixed array of pixels in a digital camera or projector creates a stable grid of image sites. But the image sites on a film frame are the microscopic crystals embedded in the emulsion and activated by exposure to light. Those crystals are scattered densely throughout the film strip at random, and their arrangement varies from frame to frame. So the finest patterns of light registration tremble ever so slightly in the course of time, creating a soft pictorial vibrato.

Another source of the film look is pointed out by Jeff Roth, a postproduction expert at Focus Features. Jeff notes that a video chip is a flat surface, with the pixels activated by light patterns across the grid. (We forget that in the earliest stages, "digital" image capture is "analog"—that is, photographic—before it gets quantized and then digitized.) But a film strip has volume. It seems very thin to us, but light waves find a lot to explore in there. Light penetrates different layers of the emulsion: blue on top, then a yellow filter, then green, then red. The light rays leave traces of their passage through the layers.

João S. de Oliveira puts it more rhapsodically:

> There is a certain aura in film that cannot exist in a digital image.… From the capture of a latent image, the micro-imperfections created by light on a perfect crystalline structure—a very three-dimensional process—to its conversion into a visible and permanent artefact, the latitude and resolution of film are incomparable to any other process available today to register moving images.

For example, shadows and highlights are captured "deeply." Bright areas move into shade gracefully. Similarly, film is far more tolerant of overexposure than digital recording is. Blown-out areas of the negative are still there, but in digital imagery they're gone forever.

Film shown on a projector maintains the film look captured on the stock: You're just shining a light through it. We've all heard stories, however, of those DVD transfers that buff the image to enamel brightness and then use a software program to add grain. One archivist tells me of an early digital transfer of *Sunset Blvd.* that looked like it had been shot for HDTV.

Today carefully done digital transfers can preserve some of the film look. 2K projection can at times look "videoish," with aliasing, jagged edges, and the like, but it can also preserve a certain graininess. Some qualities of the film look can be retained in digital transfers.

Which is to say that I'm becoming reconciled, even as a film wonk, to the loss of the film look. But I'm grateful to all the people who raised a clamor in the early 2000s. Had filmmakers and cinephiles welcomed the earliest digital systems, we might now

have something quite awful. Probably the resistance from directors and cinematographers helped push the standard to 2K.

The sizzle

Concern about the film look, or even minimal visual quality, isn't widespread, though. A little while ago I went to a Japanese film shown at our town's best theatre. The distributor, a very small one, had only one print and wouldn't ship it. The film was sent on Blu-ray. It wouldn't play. Two more Blu-rays were sent, and neither would play. The film was shown on DVD on a twenty-foot screen, and it looked dreadful.

I walked out, but nobody else did. The dozen or so people there stayed. Did they notice? Did they care?

This inability to see differences in image quality isn't new. In a University course, I once showed a 16mm print of *Night of the Living Dead*, and a faculty friend, a fan of Romero's movie, came to the screening and my followup lecture. I showed clips on VHS, dubbed from a VHS master. Afterward he swore that he couldn't tell any difference between the film and the second-generation VHS tape.

My friend knew the film very well, and he'd watched it many times on VHS. Did he somehow see the 16mm screening as just a bigger tape replay? Did none of its superiority register? Maybe not.

Our senses have evolved to be remarkably stable across millennia, but perceptual uptake—what we notice or ignore, what we expect to see and can't catch—can vary. From 1915 to 1925, Thomas Edison demonstrated his Diamond Disc Phonograph by inviting

audiences to compare live performances with recordings. Singers would start a song, then stop while the record continued, and then the singer would pick up the thread of melody. These "Tone Tests" toured the world, and according to Edison's publicity, the millions of people in audiences couldn't reliably distinguish the performers from the recording.

Edison's sound recording was acoustic, not electrical, and it sounds hopelessly unrealistic to us today. Yet if his audiences were fairly regularly fooled, it suggests that our sense of what sounds, or looks, right is both untrustworthy and changeable over history.

To some extent, what's registered in such instances aren't perceptions but preferences. Wholly inferior recording mechanisms can be favored because of taste. How else to explain the fact that young listeners prefer MP3 recordings to CDs, let alone vinyl records? It's not just the convenience; one researcher hypothesizes that listeners like the "sizzle" of MP3.

Likewise, computer monitors and HD television seem to have cultivated a taste for crisp, over-sharp images and sounds. Go to a big-box store and look at the ranks of TV monitors on display. These are casual experiments in how widely different digital images can look; and consumers find all of them acceptable, even dazzling. Frame-interpolation settings on many monitors accustom viewers to even more hard-edged pictures. Perhaps people who've grown up on digital media take such scrubbed, sizzling imagery as the way that movies are supposed to look. It becomes a feature, not a bug.

Artifact into abstraction

Other areas of loss can be plotted. When 35mm prints are unavailable, it will be difficult for scholars to perform certain kinds of film analysis. In order to discover things about staging, lighting, color, and cutting in films that originated on film, scholars have in the past worked directly with prints.

For example, I must sometimes count frames to determine editing rhythms, and working from a digital copy isn't reliable for such matters. Likewise, analysts of visual style need to freeze a scene on an exact frame. For live-action film, that's a record of an actual instant during shooting, a slice of time that really existed. It encapsulated something about a character, the situation, or the spatial dynamics of the scene. Paolo Cherchi Usai suggests that for every shot there is an "epiphanic frame," an instant that focuses the expressive force of that shot. Working with a film print, you can find it. On video, not necessarily. A DVD freeze-frame on a monitor is a compromise, and may not represent any actual photographic frame. It can also differ from one DVD player to another.

More evident are other pictorial factors. For films originating in 35mm, we can't assume that a digital copy will respect the color values or aspect ratio of the original. Often the only version available for study will be a DVD displaying unfaithful color and a different ratio. Researchers need to be able to go back to 35mm for study purposes, at least for photographically generated films. Silent films are the most problematic; only 35mm copies can yield a sense of original aspect ratios, tonal values, and frame rates. For digitally originated films, we ought to be able to go back to the DCP as re-

leased, but encryption and intellectual property concerns will make that impossible.

In losing the artifact, we gain, as George Dyson puts it, only a very long number sitting in a file. The effects of this change spread far beyond the small circle of film researchers. The digital revolution has changed both the film industry and the cultural roles that cinema may perform. Let me conclude this book by pointing out two dimensions of these changes.

First, films are now swept up into that format churn characteristic of information technology. Anyone with a personal computer is familiar with the dizzying cascade of operating systems, upgrades, patches, and fixes. Windows 1.0 (1985), Windows 2.0 (1987), Windows 3.0 (1990), Windows 95, Windows 98, Windows 2000, Windows XP (2001), Windows Vista (2006), Windows 7 (2009): the convenience of computers comes at the price of rapid obsolescence. Software is pegged to a certain version and its successors, so new applications may not play on earlier versions. Hardware is affected as well. Where now are the Microsoft-driven SonicBox (a remote control for playing music on your computer), Clarion AutoPC (a digital player for your car), cameras deploying Windows Movie Maker, Casio Color Cassiopeia (a personal digital assistant for pictures and movies), and I-Jam (a portable music player)? All were touted in 2000 as the next big things for the new millennium.

Computing power doubles roughly every eighteen months, and we push against our machines' capacities (text, then pictures, then music, then movies). In this give-and-take, we've adapted to the

whirligig of information technology. 35mm cinema was comparatively stable. The big revampings of it, such as Cinerama and Todd-AO, were mostly for roadshow situations and weren't intended for universal deployment. But once every projector becomes a computer, it's as ephemeral as any piece of IT. Every device becomes a transition to the next one.

When Lucas launched *Star Wars: Episode I—The Phantom Menace* in 1999, he was convinced that projection at 1.3K resolution would suffice. Six years later 2K resolution was settled on, rendering the first wave of projectors obsolete. But Sony had already raised the stakes by backing 4K resolution, so in 2009 Texas Instruments had to launch its own 4K system, the so-called "second series." At first, the Regal and AMC theatre chains had embraced the Sony technology; their bulk orders helped get it off the ground. In 2011 AMC began quietly buying its 4K projectors from DLP-based rivals, apparently because of the problems of playing non-3D movies on Sony machines.

As I write this, the carousel is spinning faster. In April 2012, at the annual meeting of NATO, Christie announced a new chipset. The S2K, available some time late in the year, would meet DCI specifications for screens twenty feet wide or less. Expected to be priced significantly less than a full-blown projector, the new initiative was clearly an effort to attract smaller exhibitors, both at home and abroad. It would open the prospect of letting 1.3K houses in emerging markets upgrade to play DCI-protected Hollywood content.

A major problem with 3D images has been dimness. 2D pictures are three or four times brighter. One answer, proposed at the same

April ShoWest convention, was laser light sources. Barco announced a new model projector that displayed images with a new brilliance and sharpness, promising full 4K resolution for each eye in stereoscopic cinema. A January demonstration on a 72-foot-wide screen had been greeted with enthusiasm, but the April one left a dispiriting air. "Theater owners," noted one reporter, "may not be in a mood to buy after collectively spending $2.5 billion to convert to digital projection." The demo, was merely, according to a Barco competitor, "a glimpse into the future."

A more immediate solution to the dimness problem was a higher frame rate. Like 3D, this got the support of celebrity directors. In an echo of his 2005 peroration, James Cameron told theatre owners in 2011 that projecting at 48 frames per second, better yet 60, would yield brighter 3D displays and smoother movement. Cameron claimed that the equipment would need only "little tweaks," a mere software upgrade. In 2012, Sony seemed to confirm this by indicating that it could supply high-frame-rate software for about $3000 per machine. But the manufacturer Christie suggested that Cameron's proposal might require retrofitting a projector with hardware costing $10,000.

Peter Jackson responded to Cameron's call by shooting *The Hobbit* at 48 fps digital and then screened footage at that rate at the 2012 NATO convention. The press reported that many exhibitors found the result unnerving: too sharp, too much like HD video. (The film was also shot in 5K, an unusually high resolution for production.) Jackson defended the result as more lifelike and less likely to provoke eyestrain. "It's more immersive and in 3D a gentler way to see

a film." He predicted that audiences would accommodate to it as quickly as he and his crew had. He gained support from the Regal cinema chain, which announced that it planned to upgrade as many as 2700 projectors to the 48 fps rate. As a result, *The Hobbit* was planned to be shown in no fewer than six different formats (2D, 3D, and Imax, each one at either 24 fps or 48 fps).

The higher frame rate is driven by the tentpole and franchise side of the mainstream industry, as a Christie press release makes clear.

> The "Soap Opera Effect" has been derisively used to describe film purist perceptions of the cool, sterile visuals they say is brought on by digital.
>
> But the success of Hollywood, Bollywood and big-budget filmmakers around the world has little to do with moody art-house films. The biggest blockbusters are usually about immersive experiences and escapism—big, vibrant, high-action motion pictures.

Once more, an innovation designed for the top end of the industry is being forced on exhibitors en masse. A few years ago the future of cinema was 3D; now, says Christie's brochure, "The future of cinema is all about high frame rates."

Having pressed for digital cinema because of 3D, Cameron and Jackson were now wrestling with some of 3D's shortcomings—mechanical ones, not artistic ones. Cameron had warned exhibitors in 2005 that if 3D theatres didn't arrive, people would stay home with their flat-screen TVs, but now he shifted the goal posts. According to *Variety*, "Cameron argued that exhibitors cannot afford to make

the case that 'What you're going to see is special and better than what you have in your home, except the motion sucks.'"

Cameron is open to charges of bad faith. His company supplies 3D production and consultation for television, and holds contracts with ESPN and CBS Sports. In 2012 he proposed that episodic TV shows should also be shot in 3D. "If you're not broadcasting in 3D you're not playing the game and you're not getting any revenue." He has also talked enthusiastically about 4K television. So much for giving theatre owners an edge over the home market.

But the move isn't entirely a matter of self-interest. Lucas, Cameron, and Jackson have grasped that once cinema becomes digital all the way down, it becomes what the IT people call a platform. A platform (think of DOS or iOS) becomes the basis for constantly revised standards and ever-expanding functions and possibilities. A platform generates a vast amount of innovation, development, and obsolescence. Film exhibition, once a stable technology undergoing only mild alterations, will henceforth suffer change that is fast, radical, unpredictable, and perpetual.

Sony's new slogan for 4K projection is "Innovation with No End in Sight," and it is accurate. Theatre owners may not have realized how much money they will be spending every five to ten years on upgrades, new software, and next-generation machines. But gearhead directors who understand digital churn and see artistic problems as matters of gadgetry can exploit this volatility to underwrite expensive stuff they think it would be cool to try. The manufacturers, who need to keep selling new machines, are eager to go along.

Coming immediately to a theatre near you

Apart from churn, there's a broader social consequence of digital projection. The projector-as-computer inserts cinema into what has become an on-demand popular culture.

For about seventy-five years, movies were an appointment medium and a service industry. Virtually no one owned personal prints, so if you wanted to see a film, you went to a movie theatre. You were given very few chances to see it again. Broadcast television changed that when local affiliates and big networks began filling the airwaves with movies from studio libraries. You could re-see old classics, but you could select only from what was on offer day by day.

With the saturation booking that emerged in the 1970s, the old system of runs was weakened. Now people in Peoria could see the movie on the same day that people in New York did. Then along came consumer videotape, which created two revolutionary changes. First was time-shifting: The viewer could record whatever was on TV and watch it at his or her convenience. Just as important, the film or TV show became a physical artifact in the hands of the consumer.

Now viewers had much greater control over what they watched and when and where they watched it. Once the studios realized that videocassettes were a profit center, they opened up their libraries for sale and rental. At the same time, the expansion of cable television made more movies available than ever. You could watch a film on cable and tape it, or rent it in order to watch it again, or simply wait until the cable channel re-ran it, which was likely to be soon.

What had been a service industry operating by appointment—you go into a movie house or turn on the TV at a specified time and have an experience and come away with nothing tangible—had become a consumer-goods business as well. In this split mode the film industry worked very well for a couple of decades, with cable and cassettes/DVDs replacing the old system of second-run, third-run, and revivals. Viewers got increasingly used to seeing films at their choice or whim. "What shall we rent tonight?" was heard in households around the land. Those who planned a bit ahead could rely on Netflix to ship their packaged entertainment to them.

Cable television and DVDs rapidly became the most profitable segment of the studios' operations. At the same time, however, shifting from analog tape to digital disc made the films perfectly reproducible. Piracy, always the best distribution system, provided access to a movie as soon as it was released, sometimes before. Web 2.0 provided faster download speeds, so bootlegging took off. At first it took a day or a night to download a file, but BitTorrent and other peer-to-peer protocols made that process much faster. By 2012, peer-to-peer networks comprised over half of all Internet traffic, and a downloaded DVD-quality copy could be on your monitor in thirty minutes or less.

The Majors, panicked by piracy on a previously unimaginable scale, have had to consider new options. Packaged media will probably be with us for quite some time. Its profit margins are very large, and many people prefer to own discs and the bonus materials that

come with them. Still, the number of those people has diminished since 2004, when sales of DVDs began to slump.

In response, the studios have tried to turn the industry back toward providing a service, but now in the ancillary realm outside the movie house. Offering legal downloads and streaming in effect splits the difference between immediate access and control of the artifact. As long as people can get their movies whenever they want, they don't need to own copies. Recently Walmart and Warner Bros. have initiated "disc-to-digital" plans. Here the consumer pays a small fee to have a DVD or Blu-ray uploaded to the Cloud, where it can be accessed from various devices.

The new ecosystem demands that studios turn their libraries inside out. They must anticipate every consumer demand, make as much available as possible, and pump their product through many channels. The cable option of Pay Per View, and the online models of Video on Demand, subscription streaming, and download-to-own generate less income than the sale and rental of DVDs and Blu-rays. The good news is that monthly spending on entertainment per household has risen. Streaming, while growing, constitutes less than one percent of this total; most of it comes from cable television, thanks to its popular all-you-can-eat subscription premise.

How do these changes affect theatrical exhibition? People still love movies a lot. In 2011, consumers worldwide paid for access to 12.4 billion films in all formats, yielding a total spending of nearly $63 billion. Theater admissions amounted to about a half of that, but movies have now been available in such abundance that other venues compete for viewers' time. Both at home and overseas, the-

atre attendance is falling off somewhat, and exhibitors have been looking for something to grow their customer base. 3D presentations, along with Imax screens and alternative content, have not so far done that. Most worrisome, in America a third of the population never goes to the movies, and the number of frequent moviegoers under twenty-five has been declining. Theatres now face pressure to find something more agreeable to the on-demand culture.

Hence some exhibitors are discussing letting spectators have their "second screen" so that they can tweet, surf the Net, and send instant messages. One young man in a focus group said, "Sitting in the dark unable to talk to my friends either in person or virtually is not my idea of a good time." Since multitasking during screenings is unlikely to go away, some exhibitors are thinking that they might as well encourage it and lure more bodies into the theatre.

The I-want-it-now impulse goes further, however. Once films are digital, in principle nothing stops exhibitors from adjusting their schedules to suit what they imagine customers might prefer. Already people, not necessarily wearing beanies with propellers on top, are suggesting that someone could gather Facebook friends to request an off-hours screening of a classic. The social network programs the movies to its taste and at its convenience.

Early in 2012 Tugg, a "collective action web-platform," announced plans to bring specialty films to art houses via advance reservation. The press release explains:

> Individuals are empowered to select a film, screening time, and nearby theater, and then spread the word to their immediate and online community. Once a necessary amount of people commit to attending, the

event will be confirmed, and Tugg will reserve the theater, manage ticketing, and ensure delivery of the film.

As one writer puts it, "*We Need to Talk about Kevin* opened in New York on December 9th but it won't open where I live until March 2nd. Instead we wait for indie films to come to one of our three art house cinemas.…It sucks." The idea that the hinterlands must be patient, the basic premise of a platform rollout, is anathema in the on-demand age.

With a 450-film library of foreign classics, cult favorites, newish arthouse titles, studio releases a few years old, and microbudget indies, Tugg can provide targeted-audience movie nights. A similar enterprise is Gathr, which also identifies itself as "TOD"—Theatrical on Demand. The films are most likely to be on 1.3K formats, rather than Hollywood's proprietary 2K one, but presumably most audiences wouldn't care. Many will come not to experience the film but, we might say, to experience the experience.

Will enterprises like Tugg and Gathr prove successful? Could exhibitors work out deals with distributors to free up screens in off-peak hours? I don't know. What seems evident is that digital exhibition makes such grassroots-curated programming more feasible. Exhibitors reluctant to book current art-house releases for week-long runs would welcome the efficiency of a single night's screening that draws everybody in town who wants to see a particular film. Exhibitors can program one-off specialty shows on their own through delivery systems like Specticast or Emerging, but with the bottom-up model, the exhibitor would have a guaranteed turnout.

During the slack nights the multiplex screen can become a film society or ciné-club, though advocates would probably prefer to think of it as a really big living room.

What survives of pre-digital cinema? For one thing, the craft routines and language of film. The phases of production, the creative options open to filmmakers, the expressive possibilities of framing and cutting have all remained as a template for digital work. We still have storyboards, tracking shots, color correction, sound mixing, low-key lighting, and all the rest. It's merely that these items and tasks are now executed digitally. Digital cinema may lack the "film look" but it presents itself as, still, cinema.

What also survives, as I've suggested throughout, are the power structures of the Hollywood industry. The distribution sector still dominates. A few studio conglomerates and theatre chains rule film culture. The major players, including manufacturers and professional associations, cooperate to create calm technological transitions and to maintain barriers to entry. Worries about intellectual property take precedence over convenience or common sense. These are patterns of thought and action that we've seen across a hundred years of American moviemaking.

Despite all that, theatres remain more than showrooms for product or content. They draw strangers together, and bind a community, and offer occasions for experiences that sometimes linger in memory. Festivals stubbornly insist on presenting, to growing numbers, forms of cinema that aren't thinkable in Hollywood terms. Archives not only preserve the past but display it, in venues

that governments and patrons have wisely decided should be maintained. Now that those in the rich world, and many in the developing world, have cinema as both artifact and service, by appointment or at whim, they will find their world expanded as we purist cinephiles found ours.

Maybe I'm not such a purist after all. I can't mock the kid who watches *Melancholia* on VOD, or *His Girl Friday* on an iPhone. Is it any more absurd than me watching *The Wizard of Oz* on a small black-and-white TV in the 1950s, or *Potemkin* on 8mm in the 1960s, or *La Passion de Jeanne d'Arc* on a 16mm dupe in the 1970s? In these and many other encounters, something powerful came through and led me forward, regardless of the faults of the format.

Cinema survives in yet another way. Everybody notices that our computer devices make friends with us through homely analogies. The screen is organized as a desk area, holding documents, files, folders, and a trashcan. An e-book has pages, not a continuous scroll; it offers chapters and bookmarks. And wherever you turn in popular culture, you find that graphic design evokes movies through icons that have become utterly anachronistic. We see pictures of film reels, sprocket holes, countdown leader, and coils of movie film spilling up out of cans or weaving their way through projectors—all things are on their way to disappearing.

These icons will endure, I think. There's no way to admire, let alone romanticize, the dead black box of a digital projector, that computer with a light bulb inside, or a disc with a big number sitting on it. How do we venerate a director when he or she can't be seen holding a bit of film up to the light (cigarette optional) or

studying it on a flatbed? The image of miles of film curled up tight on a platter or tangled on the floor is part of the identity of cinema. Outdated as it is, we seem to have no other way to think about this medium.

If analog cinema survives only as a metaphor, or a *memento mori*, that might not be the worst thing to happen. Images of clunky nineteenth-century technology, all mechanics and chemistry and electricity, will remind us that what happens today has a history. Mourn it or mock it, our past persists right now, and these humble emblems help us recall what cinema has bequeathed to our civilization.

References and Further Reading

For ease of reading, this book omits the usual machinery of numbered notes and citations. Much of what I cite can be found in a quick web search using idiosyncratic keywords. I've also not inserted hyperlinks in the text, which I think would be distracting. In the references that follow, I've supplied links for readers who want to explore matters further or visit some of the sources I've used.

Throughout, box office figures for recent releases are taken from Box Office Mojo. Supplementary material is given in the references for specific chapters. Many of the articles and reports I consulted, however, are proprietary or available online only by subscription.

Statistical and trend-based information in the book came from back numbers of *Variety*, *The Hollywood Reporter*, *Variety Deal Memo*, and above all *IHS Screen Digest*, the premiere source for media industry data and analysis. An information-packed 2006 report from *Screen Digest*, "Digital Cinema: Rollout, Business Models and Forecasts to 2010," by David Hancock and Charlotte Jones, is available online. I'm particularly grateful to David Hancock for sharing supplementary information in a swift, cheerful manner.

In general, a very helpful source on digital cinema is Michael Karagosian's website.

Introduction: Changeover

For an overview of the death of 35mm, see David Hancock, "Thanks for the memories: It's the end of an era as 35mm film declines," *Film Journal International* (23 December 2011). Grady Hendrix offers a lyrical portrait of the endangered species of projectionist.

Chapter 1: The Last Redoubt

A superb, detailed account of how popular culture industries utilized computers is provided in Chapters 8–12 of James W. Cortada's *The Digital Hand, vol. 2: How Computers Changed the Work of American Financial, Telecommunications, Media, and Entertainment Industries* (New York: Oxford University Press, 2006). For a survey of the development of digital changes in the film industry, see Chapter 30 of *Film History: An Introduction,* by Kristin Thompson and David Bordwell (New York: McGraw-Hill, 2010).

Lucas's earlier innovations are chronicled in Michael Rubin's *Droidmaker: George Lucas and the Digital Revolution* (Gainesville, FL: Triad, 2006). Dauntingly complete accounts of the making of Lucas's trilogy can be found in these issues of *Cinefex*: no. 78 (July 1999) for *The Phantom Menace*; no. 90 (July 2002) for *Attack of the Clones*; and no. 102 (July 2005) for *Revenge of the Sith*. My quotations on pp. 23 and 30 come from these sources. The remark about erasing actors' eyeblinks comes from Benjamin Bergery, "Digital Cinema, By George," *American Cinematographer* 82, 9 (September 2001), 71. The 1997 quotation on p. 28 is from Kevin Kelly and Paula Parisi, "Beyond *Star Wars*: What's Next for George Lucas,"

Wired (February 1997), 166. The 2006 quotation on p. 45 is from Richard Corliss, "A Conversation with George Lucas," *Time* (14 March 2006). The comment from Lucas' editor on *The Phantom Menace* comes from Cheo Hodari Coker, "Brave New Worlds," *Premiere* (May 1999), 88. The promotional ad for the first *Phantom Menace* screenings is in *Variety* (21 June 1999), 23.

Robert Christopher Lucas shows in admirable detail how professional cinematographers responded to the rise of digital image capture. See "Crafting Digital Cinema: Cinematographers in Contemporary Hollywood" (Ph. D. dissertation, University of Texas at Austin, 2011). See also John C. Hora, "ASC Statement on Digital Cinema," *American Cinematographer* 81, 8 (August 2000), 135, and Bob Fisher, "The ASC and DCI Join Forces to Set Standards for Digital Projection," *American Cinematographer* 85, 1 (January 2004), 121–122. Roger Deakins' praise of the Arri Alexa comes from Jay Holben, "Time Bandit," *American Cinematographer* 92, 11 (December 2011), 34–35.

Clayton M. Christensen's influential formulation of the theory of disruptive technologies is in *The Innovator's Dilemma* (orig. 1997).

It's hard to know how widely 16mm prints were exhibited commercially around the world, but some indications are given in *Statistics on Film and Cinema 1955–1977* (Paris: Unesco, 1981) and various editions of the *UNESCO Statistical Yearbook*.

Shujen Wang's informative *Framing Piracy: Globalization and Film Distribution in Greater China* (London: Rowman and Littlefield, 2003) goes into great detail on the growth of VCD. In *Playing to the World's Biggest Audience: The Globalization of Chinese Film*

and TV, Michael Curtin goes beyond technology and analyzes other market forces affecting VCD. Other facts and figures I deploy came from *IHS Screen Digest* and "Country Profile: China," *Variety Deal Memo* (11 October 1999), 5–8. Useful reports on the progress of VCD appeared in *The Economist* here and here. I talk a bit about the rise of digital exhibition in China and Hong Kong in *Planet Hong Kong*, available here.

For basic historical and technical information on consumer digital playback formats I always turn to Jim Taylor, Mark R. Johnson, and Charles G. Crawford, *DVD Demystified*, 3rd ed. (New York: McGraw-Hill, 2006).

The rhythm of 1.3K pickup in India and China accords with the general patterns of IT diffusion in those countries. See Chapters 9 and 10 of James Cortada's *The Digital Flood: The Diffusion of Information Technology across the United States, Europe, and Asia* (New York: Oxford University Press, 2012). The quotation from the Nigerian filmmaker Dayo Ogunyemi on p. 40 comes from Christopher Vourlias, "African filmmakers welcome screen blitz," *Variety* (9–15 April 2012), 6. The quotation on p. 45 is taken from Anita Kohli-Khandekar, "Q & A: Kapil Agarwal, Joint MD, UFO Moviez," *Business Standard India* (17 October 2011).

On TV broadcasts in theatres, see Douglas Gomery, "Theater Television: A History," *SMPTE Journal* 98, 2 (February 1989), 120–123. On Hollywood's experiments with digital projection, see Matt Rothman, "Digital tech points to pix' future," *Variety* (12 May 1992), 1, 4; and Katharine Stalter, "Digital cinema hovers on hi-tech horizon," *Variety* (12–18 June 1995), 9, 16.

The report on the 1999 Denver tests of six digital systems comes from Andrew Hindes, "When prints will no longer be king," *Variety* (25–31 January 1999), 9. The trade advertisement for the digital screening of *The Phantom Menace* appeared in *Variety* (21 June 1999). My account of the technology used in the screening relies on Jay Holben, "New Paths for Light," *American Cinematographer* 80, 9 (September 1999), 70–71. Bill Kinder explains the digital workflow for the 1999 Pixar release in "An All-Digital Pipeline: *Toy Story 2* from Disk to Screen," *SMPTE Journal* (December 2000), 946–948.

John Belton provides a careful discussion of the 1.3K system and its likely future in "Digital Cinema: A False Revolution," *October* 100 (2002), 98–114. He notes that it promised no novelty sufficient to convince theatre owners to convert. In a few years, 3D would provide the extra push.

The Route 4 Stanley Warner Theater in Paramus, where *The Phantom Menace* ran in digital, was built in 1965 as a roadshow house. It had shown all the films in the first trilogy in exclusive 70mm engagements, and on its closing night in 2007 it was permitted to screen a print of *A New Hope* for employees before it shuttered forever. It is now a physical fitness club. For more information, go here.

Chapter 2: From E-Cinema to D-Cinema

The quotation from George Lucas at the start of the chapter comes from the 2005 article by Kathy White, "'Star Wars' Remains Ahead of the Digital Curve." The same article furnishes the quotation about plug-and-play on p. 56. The quotation from John Fithian in

the opening paragraph comes from Kerrie Mitchell, "Can Film Be Saved?" *Premiere* (May 2003), 41.

The quotation from Michael Karagosian on p. 53 is from "Newco Digital Cinema: Technical Issues Come Home [2002]."

The studios and their affiliated organizations, notably the Academy and the American Society of Cinematographers, have long coordinated technological innovation with manufacturers and supply firms. For a historical account, see Parts Four and Six of *The Classical Hollywood Cinema: Film Style and Mode of Production to 1960* (New York: Columbia University Press, 1985), by Janet Staiger, Kristin Thompson, and David Bordwell. The comment about the studios' fears of losing distribution power (p. 55) comes from "Digital cinema's picture starts to fade," *Variety Deal Memo* (15 July 2002), 12. See also "Electronic projection rollout excites, worries cinema industry as cost, quality, retrofit issues loom," *Variety Deal Memo* (5 July 1999), 5–8. The quotation about parasitic gatekeepers (p. 55) is from Phil Barlow, as reported in Tim Carvell, "Hello, Mr. Chips (Goodbye, Mr. Film)," *Fortune* (16 August 1999).

An early outline of SMPTE's ambitions for digital cinema is "Status Report: D-Cinema Technology Committee," ITEA Seminars (Los Angeles, January 2001). John Fithian's 2003 letter to Chuck Goldwater is reproduced here.

At the moment of writing, the DCI's 2005 specifications for digital cinema are available here. Note that there have been many subsequent revisions of the document.

Did the Digital Cinema Initiatives consortium receive formal permission from the Department of Justice to proceed? The

Wikipedia page devoted to the Digital Cinema Initiatives asserts that Tom McGrath, then Chief Operating Officer of Viacom (owner of Paramount Pictures) "applied to the U. S. Department of Justice for anti-trust waivers to allow the joint cooperation of all seven motion picture studios." This claim has been repeated in many other websites. A search of the legal record reveals no evidence of this, and my query about it to Mr. McGrath has received no reply.

The quotation about Sony's smarts on p. 63 is from Andrew Stucker in Sheigh Crabtree, "Sony promises '05 debut after 4K d-cinema's demo," *Hollywood Reporter* (8–14 June 2004), 67.

Chapter 3: King of the World

A perceptive overview of digital distribution and exhibition is Charlotte Crofts, "Cinema Distribution in the Age of Digital Projection," *Post Script* 30, 2 (Winter–Spring 2011), 82–98. Benjamin J. Birkinbine analyzes the Big Three theatre chains' operations during the transition in "Continuity in Technological Change: A Political Economic Analysis of Digital Film Exhibition" (M. A. Thesis, 2010, Southern University of Illinois Carbondale).

Kristin Thompson has pointed out that the industry's calculations of the format's value to the box office may have been off-base from the start. Those calculations are based on the number of tickets sold for 3D shows as a proportion of total ticket sales. But probably almost all of the patrons of a 3D show would have come to the film if it had been only in 2D, so the real value of the stereoscopic format lies in the difference between the two ticket prices, the upcharge. There was no evidence that 3D on its own attracted much

extra business—that is, that people would come see a 3D film solely because it was in 3D. The decline in 3D box-office returns in 2011, even as computed by the MPAA, seems to indicate that this is the case. See Thompson's blog entries here and here and here. See also "3D Movies Languish at US Box Office," *IHS Screen Digest* (February 2012), 37.

Chapter 4: Pay No Attention to the Man Behind the Curtain! (He's Not There Anyway)

For an in-depth introduction to the Digital Cinema Package, see "Digital Cinema Technologies from the Archive's Perspective," *AMIA Tech Review* (October 2010). The Film-Tech Forum is an informative chat room concerning projection and general film matters. Examples of NOCs in action have been provided in videos by Christie and XDC.

Chapter 5: The Road to Harmony

On the U.S. theatrical market, I've drawn data from *The NATO Encyclopedia of Exhibition*, various years, and the annual reports of the Motion Picture Association of America. See also Adam Thomas et al., *Global Film: Exhibition and Distribution*, fifth ed. (London: Informa, 2002). A detailed account of the 1999–2001 bankruptcies can be found in Adam Thomas et al., *U.S. Electronic Media and Entertainment* (London: Informa, 2003), 65–82. An invaluable web tool for studying particular theatres is Cinema Treasures, and I've taken advantage of it.

My primary guide to the growth of multiplexes and megaplexes is Douglas Gomery's indispensable *Shared Pleasures: A History of Movie Presentation in the United States* (Madison: University of Wisconsin Press, 1992). See also William Paul's cornerstone 1994 article, "The K-Mart Audience at the Mall Movies," in *Moviegoing in America*, ed. Gregory A. Waller (Malden, MA: Blackwell, 2002), 282-295. Richard W. Haines offers insider information about multiplex projection in *The Moviegoing Experience, 1968–2001* (Jefferson, NC: McFarland, 2003). Charles R. Acland provides a nuanced account of the global forces driving the 1990s theatre-building boom in "'Opening Everywhere': Multiplexes and the Speed of Cinema Culture," in *Going to the Movies: Hollywood and the Social Experience of Cinema,* ed. Richard Maltby, Melvyn Stokes, and Robert C. Allen (Exeter: University of Exeter Press, 2007), 364–382. See also Acland's *Screen Traffic: Movies, Multiplexes, and Global Culture* (Durham: Duke University Press, 2003).

I thank Duke Goetz and Mrs. Robert Goetz for talking with me about the family business. Thanks as well to Matt Figli, local historian. The history of the theatres can be found on the Goetz website. Other information comes from volumes of *The Film Daily Yearbook* and issues of *The Monroe Evening Times* of 1 September 1931; 23 December 1956; 22 October 1981; and 15 May 2001. Also very helpful was *Pictorial History of Monroe, Wisconsin*, ed. Matthew L. Figli (Green County Historical Society, 2006). Thanks also to the staff of the Monroe Public Library. Leon Goetz is credited with producing at least two films, *Ten Nights in a Bar Room* (1931) and *The Call of the Rockies* (1931).

Thanks as well to Michelle Haugerud for her cooperation. Her informative JEM website starts here. The page devoted to the digital upgrade traces the fundraising process and records her gratitude to the community. On the same page, scroll down to see a video of Paul running the last 35mm show.

During my time in Harmony, I couldn't get access to much material about the JEM in the old days. According to *The Film Daily Year Book*, the original JEM Theatre opened in the mid-1930s. It burned down in 1940. The building next door was renovated as the New JEM, which opened in September of that year. A plain-spoken house of 325 seats, it had fluorescent lighting, satin curtains, three layers of acoustic tile, and a big furnace for the cold months. Its estimated cost was $18,000. For the premiere, a four-page color brochure was printed and sent to 3000 homes in the area. The publication was "made possible thru the whole-hearted cooperation of the businessmen of Harmony who fully realize the value and convenience of this modern, good-looking theatre." This information comes from "Harmony, Minnesota, Salutes New Jem Theatre, S. E. Minnesota's Finest Showplace!" *The Harmony News*, flyer dated September 1940. For a fuller chronology, go to Michelle's page on JEM history.

Marilyn Bratiger explains the name of the theatre to me. "Relatives of mine were the original owners: Joseph Milford Rostvold and his wife, Emma. The J was for Joseph Sr. and Jr., the E for Emma and their daughter Elizabeth, and the M for the senior Joseph's middle name, Milford, which was the name he was known by. There

was a third child, Richard, but they didn't use his initial as they didn't want the theatre to be called JERM."

On the Cinema Buying Group, see G. Kendrick Macdowell, "Reflections on the Fate of the Independent Exhibitor," *Digital Cinema Report* (27 August 2009) and "The Cinema Buying Group Turns Five," *Digital Cinema Report* (13 October 2011).

My figures on theatres that closed during the conversion to sound come from *The Film Daily Yearbook* from the years 1931–1935. The process, which has many analogies with today's digital conversion, is discussed in Donald Crafton, *The Talkies: American Cinema's Transition to Sound 1926-1931*, vol. 4 in *History of the American Cinema*, ed. Charles Harpole (New York: Scribners, 1997), Chapter 11, and Douglas Gomery, *The Coming of Sound* (New York: Routledge, 2005), Chapter 8.

Stanley Durwood's comment on p. 110 is quoted in Richard Setlowe, "AMC topper's bright idea got multiplex ball rolling," *Variety* (5 May 1996), N2. The quotation on p. 126 comes from Richard H. Orear, "Where Are Our Future Patrons?" *Encyclopedia of Exhibition 1980* (National Association of Theatre Owners, 1980), p. 11. John Fithian's remarks about the elimination of low-grossing theatres is quoted in Richard Verrier, "Small theater operators weigh digital conversion," *Los Angeles Times* (19 April 2011).

Chapter 6: Art House, Smart House

The survey results I mention come from work by Juliet Goodfriend, Cordelia Stone, and Valerie Temple of the Bryn Mawr Film Insti-

tute. That online survey, conducted in late 2011, collected data from 126 theatres in 29 states and Canada.

A good overview of the early development of digital art-house exhibition is offered by Michael Goldman's 2008 article, "Digitally Independent Cinema," in *Filmmaker* magazine. My reference to a Seattle theatre on p. 132 is to the Seven Gables, a Landmark house. John Fithian's remark about digital content on p. 128 comes from Jeremy Kay, "Turnaround Story," *Screen International* (March–April 2012), 9. The reference to art-house coffee comes from "'Gaucho' in U. A., at 75¢, $34,000," *Variety* (25 January 1928), 7. The *Variety* article I quote on p. 137 is "7 out of 10 Sureseaters Click" (27 July 1949), 13.

On the history of art cinemas, I've drawn upon Kristin Thompson's unpublished research on the 1920s scene and on Tino Balio's indispensable *The Foreign Film Renaissance on American Screens, 1946–1973* (University of Wisconsin Press, 2010). See also Michael F. Mayer, *Foreign Films on American Screens* (New York: Arco, 1965); Barbara Wilinsky, *Sure Seaters: The Emergence of Art House Cinema* (Minneapolis: University of Minnesota Press, 2001); and Kerry Segrave, *Foreign Films in America: A History* (Jefferson, NC: McFarland, 2004). A skillful analysis of the role of the MoMA circulating programs is provided in Haidee Wasson's *Museum Movies: The Museum of Modern Art and the Birth of Art Cinema* (Berkeley: University of California Press, 2005).

Jack Foley of Focus Features kindly provided me information on the rollout of *Tinker Tailor Soldier Spy*.

On the Landmark chain's early ambitions for digital projection, see Xeni Jardin, "The Cuban Revolution," *Wired* (April 2005), 119–121, and Ian Mohr, "Cuban rhythm shakes up pics," *Variety* (7–13 May 2007), 12. In 2011 Mark Cuban announced that he would be willing to sell Landmark, along with Magnolia distribution. No acceptable offers were forthcoming.

Chapter 7: Pandora at the Festival

Portions of this chapter have been adapted from Chapter 29, "Toward a Global Film Culture," in Kristin Thompson and David Bordwell, *Film History: An Introduction*, 3d. ed. (New York: McGraw-Hill, 2010).

Good general studies of film festivals and their place in global film culture are Richard Porton, ed., *On Film Festivals, Dekalog 3* (London: Wallflower, 2009); Marijke De valck, *Film Festivals: From European Geopolitics to Global Cinephilia* (Amsterdam: Amsterdam University Press, 2007); and Cindy Hing-Yuk Wong, *Film Festivals: Culture, People, and Power on the Global Screen* (Rutgers, NJ: Rutgers University Press, 2011).

The quotation from Roger Ebert comes from "Screen to Shining Screen," Variety (24–30 August 1998), 51.

On the Berlin International Film Festival's digital strategy, see "Digital Cinema @ Berlinale 2012."

Chapter 8: The Artworks Formerly Known as Prints

On digital restoration, see Giovanna Fossati, *From Grain to Pixel: The Archival Life of Film in Transition* (Amsterdam University Press, 2009).

Arne Nowak provides an excellent overview of how new exhibition technologies affect preservation in "Digital Cinema Technologies from the Archive's Perspective," *AMIA Tech Review* (October 2010). See also Jan-Christopher Horak, "The Gap between 1 and 0: Digital Video and the Omissions of Film History," *Spectator* 27, 1 (Spring 2007), 29–41, from which my first Horak quotation comes, and Charlotte Crofts, "Digital Decay," *The Moving Image* 8, 2 (Fall 2008), xiii-35. A compact statement of best practices for digital deposit and acquisition is that of the FIAF Technical Commission Recommendation of September 2010, available here.

Several quotations I've embedded are from participants in "Film Preservation: A Critical Symposium," ed. Jared Rapfogel and Andrew Lambert, *Cineaste* 36, 4 (Fall 2011). Additional comments can be found online here.

Other information I've cited comes from two crucial reports from the Science and Technology Council of the Academy of Motion Picture Arts and Sciences, both available online. The first, published in 2007, is *The Digital Dilemma: Strategic Issues in Archiving and Accessing Digital Motion Picture Materials.* It concentrates on strategies for safeguarding studio archives, but much of the information about archival storage is relevant generally. *The Digital Dilemma 2: Perspectives from Independent Filmmmakers, Documen-*

tarians, and Nonprofit Audiovisual Archives, was published early in 2012.

I've also drawn a great deal from Nicola Mazzanti's "Goodbye, Dawson City, Goodbye," in *AMIA Tech Review* (April 2011) and his PowerPoint presentation, "The Twin Black Hole: Key Findings and Proposals for the EU-Commissioned Study Digital Agenda for European Film Heritage," EFG Conference, Bologna, 30 June 2011. The final report of DAEFH is available here. If you think my assessment is glum, a little browsing in that report will make my comments look cheerful.

Premonitions of the problem of digital preservation came from science-fiction writer Bruce Sterling in his 2001 talk, "Digital Decay." Another prescient early piece from the same year is Howard Besser's "Digital Preservation of Moving Image Material?" *The Moving Image* 1, 2 (2001), 39–55, available here.

My account neglects the distributors who have considerable libraries but don't have the deep pockets of the studios. These tend to specialize in classics and art-house perennials, for which there is probably a market in online streaming. But the problem is that the cost of remastering and digitizing the Ealing comedies or films by Wenders is too great to be absorbed by sales to VOD websites. See Adam Dawtrey, "Digital conversion pains indies," *Variety* (7 May 2010).

Sam Kula's account of the Dawson City collection can be read in "Up from the Permafrost: The Dawson City Collection," in *This Film is Dangerous: A Celebration of Nitrate Film*, ed. Roger Smither and Catherine A. Surowiec (Brussels: FIAF, 2002), 213–218.

Conclusion: Churn

The epigraph from George Dyson is quoted in "Q & A: Hacker Historian George Dyson Sits Down with *Wired*'s Kevin Kelly," *Wired* (17 February 2012).

A very helpful introduction to the strategies of contemporary distribution is Jeffrey C. Ulin, *The Business of Media Distribution: Monetizing Film, TV and Video Content in an Online World* (Boston: Focal Press, 2010).

The Julie Andrews wayward-hair story is mentioned here.

Roger Ebert's reflections on the film look are in "Why I'm So Conservative," *Chicago Sun-Times* (6 October 2008). Brian McKernan discusses the film look in *Digital Cinema: The Revolution in Cinematography, Postproduction, and Distribution* (New York: McGraw-Hill, 2005), 67, and my quotation from João S. de Oliveira comes from an untitled piece by him in *Tacita Dean: Film*, ed. Nicholas Cullinan (London: Tate Publishing, 2011), 105.

On Edison's Tone Tests, see Greg Milner's *Perfecting Sound Forever: An Aural History of Recorded Music* (London: Faber, 2009), 5. You can sample some tunes here. On the sizzle of MP3, see Jonathan Berger here.

On frame-by-frame analysis in film and video, you can read more at our blog entry, "My name is David, and I'm a frame-counter." As for the epiphanic frame, there are many examples here. The search for the epiphanic frame is why my books, including the recent edition of *Planet Hong Kong*, rely almost entirely on frame enlargements from 35mm prints. I've written as well about varia-

tions in aspect ratios in Godard and Lang (here and here), as they differ between film and video copies.

My survey of turn-of-the-millennium techno-gadgets comes from Noah Robischon, "The Emperor Strikes Back," *Entertainment Weekly* (7 January 2000), 31.

On laser projection see "Laser focus: With new technologies, Barco proposes premium cinema experiences for all," *Film Journal* (25 January 2012). The quotations on p. 207 come from David Lieberman, "Laser Projection Is Coming, But Not in a Flash: CinemaCon," *Deadline Hollywood* (25 April 2012).

Events at the 2012 NATO CinemaCon gathering can be tracked through many press releases and reports online. On faster frame rates, see Peter Jackson, "48 Frames Per Second," Peter Jackson Facebook page (11 April 2011). The quotation from Jackson on p. 207 comes from Carolyn Giardina, "Peter Jackson Responds to 'Hobbit' Footage Critics, Explains 48-Frames Strategy," *Hollywood Reporter* (28 April 2012), and my quotation from Christie's press brochure is here. James Cameron's advocacy of frame rates and other new technology is reviewed in my blog entry, "It's good to be the King of the World." The quotation on p. 209 comes from Brent Lang, "CinemaCon: James Cameron Ramps Up His Calls for Higher Frame Rates," *The Wrap* (31 March 2011).

The matter of frame rates raises another problem for archives. In the silent cinema, frame rates of shooting and showing varied greatly, from as low as 12 frames per second to as high as 30. Archives use variable-rate 35mm projectors to show a film at the proper speed, even changing it during the screening. But the orig-

inal DCI specifications call for frame rates of 24 or 48 fps, and all the talk about changing frame rates involves raising them, not lowering them for silent cinema. The point matters because restorations of silent films will henceforth be shown on DCPs. For archivists' initial reaction to the problem, see the Technical Commission of FIAF statement, "Hollywood's Proposals for Digital Cinema—Digital Projection of Heritage Film Content at Original Frame Rates."

The development of home video and later consumer-centered technologies is analyzed in several insightful books: Frederick Wasser, *Veni, Vidi, Video: The Hollywood Empire and the VCR* (Austin: University of Texas Press, 2001); Joshua M. Greenberg, *From Betamax to Blockbuster: Video Stores and the Invention of Movies on Video* (Cambridge: MIT Press, 2008); Chuck Tryon, *Reinventing Cinema: Movies in the Age of Media Convergence* (New Brunswick: Rutgers University Press, 2009); and Dina Iordanova and Stuart Cunningham, eds., *Digital Disruption: Cinema Moves Online* (St. Andrews, Scotland: St. Andrews Film Studies, 2012). Stephen Prince provides a cogent overview of the "ancillary eighties" in *A New Pot of Gold: Hollywood under the Electronic Rainbow, 1980-1989*, vol. 10 in *History of the American Cinema*, ed. Charles Harpole (New York: Scribners, 2000).

The young man reluctant to sit alone in the dark (p. 213) is quoted in Kate Taylor, "Quiet in the audience, please," *Toronto Globe and Mail* (21 April 2012). The social-network theatre programming encouraged by Tugg is discussed in Matt Goldberg,

"Tugg.com Letting Customers Control What Comes to Their Local Theaters," *Collider* (22 February 2012).

In summer of 1999, Godfrey Cheshire published a two-part article, "The Death of Film/The Decay of Cinema." It's proven remarkably far-sighted. Cheshire predicted that within a decade your multiplex theatre would contain "a glorified version of a home video projection system." He predicted that the rate of adoption would be held back by costs. He predicted that the changeover would mostly benefit the major distributors, and that exhibitors would have to raise ticket and concession prices to cover investments. He foresaw what is now called "alternative content"—sports, concerts, highbrow drama, live events—and correctly identified it as television outside the home. He predicted the preshow attractions that advertise not only products but also TV shows and pop music. He predicted that viewers would be permitted to use mobile devices during shows. And he predicted that distractions and bad manners in movie theatres would drive away viewers who want to pay attention.

> People who want to watch serious movies that require concentration will do so at home, or perhaps in small, specialty theatres. People who want to hoot, holler, flip the bird and otherwise have a fun communal experience…will head down to the local enormoplex.

About all Cheshire missed was 3D as the killer app, but then so did nearly all of us. His essay, from *The New York Press*, isn't fully available online, but a long portion lingers here.

Statistics on current filmgoing and film-related transactions come from "Trends in US Entertainment Spending," *IHS Screen Digest* (January 2012), 15–18; "Worldwide Movie Consumption," *IHS Screen Digest* (March 2012), 61; and "Movie Consumption Stabilises," *IHS Screen Digest* (April 2012), 95–98. An early summary of the emergence of the on-demand culture is the special report, "Consumer power," *Economist* (31 March 2005).