The End of Celluloid: Digital Cinema Emerges

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Three years ago, Sony and Panavision took the first step toward a fully digital film industry when they introduced an integrated digital camera that records 24 frames per second, progressive scan at 1920 × 1080 resolution. The two partners went on to announce that Lucasfilm would use the film recorder, a modified HDW-900, for its next Star Wars title, *Episode II: Attack of the Clones*.

Since then, Hollywood has begun a major technological transformation, retooling its production and distribution business to exploit computing, broadband networks, and digital displays. Inevitably, digital cinema will reshape the entertainment business and may further blur the lines between the theatrical and home entertainment markets. Indeed, many of the components necessary for digital cinema's emergence have already been tested and proven in film production and post production.

DIGITAL IN THE STUDIO

Studios often use digital technology exclusively to produce animated films such as *Shrek*, recording them to film only as the last step before theatrical release. Even movies filmed with traditional techniques are frequently translated into digital format for nonlinear editing in post production, with substantial effects and tweaks made digitally.

Digital cinema enhances film image quality significantly, but high costs could delay its adoption.

Whether to remove an actor's blemish or to fix lighting, props, or set elements, digital technology now has a place in even the most straightforward, character-driven pictures. For example, filmmakers Joel and Ethan Coen produced *Oh Brother, Where Art Thou?* on film stock, then had special-effects house Kodak Cinecite digitize it with a scanner during post-production. Using digital techniques, technicians applied the primary post production effect—a period sepia tint—with far greater range, control, and selectivity than they could have accomplished with traditional photochemical means.

Broadband distribution of digitized films has already become commonplace in the post production world. For example, TRW's Picture Pipeline transports high-resolution dailies, effects shots, and even complete motion pictures with high security—often between continents.

DIGITAL AT THE MULTIPLEX

Profit offers the compelling reason for digital cinema's emergence. The current distribution system suffers from many costly drawbacks. For each title released, distributors must ship thousands of copies of a film, each weighing more than 60 pounds, worldwide. In North America alone, where a major release debuts on up to 4,000 of the continent's 34,000 screens, shipping costs constitute a major expense.

Given these numbers, analysts conjecture that a fully digital exhibition system could save the industry around $500 million annually. To put this figure in context, the industry's total worldwide box office revenue has yet to top $18 billion. About half that revenue goes to exhibitors, so distributors net only about 4 percent of the $9 billion that remains. A yearly savings of $500 million would thus exceed distributors' entire current income.

The film industry has plenty of other good reasons to swap out projectors for digital-cinema rigs. Film quality deteriorates through the duplication process: The release prints shown in theaters—typically four generations removed from the camera negative—suffer from much lower image resolution than the original. Further, running the film through the projector subjects it to intermittent mechanical movements that start and stop the film 24 times per second. This heavy wear produces physical defects on the film after repeated screenings, particularly if theater owners don't pay to have their projectors and film booths meticulously maintained.

Fortunately for audiences, studios' current release pattern of *front loading*—debuting a new film on the largest

number of screens possible, then running it for only a couple of weeks—effectively diminishes this drawback. Although digital cinema eliminates the problem altogether, it raises another one: It's much easier to duplicate and pirate a digital download than several cumbersome reels of film. Internationally synchronized day-and-date releases should reduce piracy significantly, however.

Moreover, digital distribution could offer studios the ability to adjust supply to meet demand—instantly. Suppose a small-budget movie generated enough word-of-mouth buzz to become a sleeper hit. Studios equipped with digital cinema technology could immediately send a download of that title to every theater that wants it. On the other hand, unsuccessful films could be just as quickly withdrawn. At the exhibition level, to avoid turning away ticket buyers, multiplex operators could load-balance dynamically by quickly shifting popular films into their larger theaters.

Digital technology makes dubbing, foreign language versions, and alternate versions such as the director's cut much easier. It would also let exhibitors run festivals, niche and special-market features, midnight screenings, sporting events, music, and possibly group interactive games at low cost.

COLD CALCULATIONS

While the potential for profit drives the development of digital-cinema technology, costs offer the major barrier to its adoption. When Texas Instruments rolled out its digital micromirror device technology, people saw for the first time a contrast ratio in digital projection that approached that of film.

Prior to DMD's development, contrast ratio had been video's biggest shortcoming. DMD's contrast ratios, which exceed 500 to 1, vastly surpass the performance of data-grade projectors like the ones that pump out PowerPoint presentations in conference rooms across corporate America.

Technophiles have fussed over acceptable compression schemes and artifacts, colorimetry and resolution, transport, security, and the like. But most consumers would be delighted—at least based on anecdotal information the industry has gathered—to watch films exhibited with today's available digital-cinema technology. Currently, however, creating these devices is prohibitively expensive, principally because of a very low manufacturing yield rate.

Theater owners won't have a compelling reason to switch from film until digital cinema provides a competitive incentive for the upgrade.

Big investment, little return

The bottom line? Installing a digital-cinema projection system in a theater runs about $150,000. That's a lot of money for an industry accustomed to spending no more than $25,000 for a film projector that will last 50 years. Certainly, projectors in theaters today show no signs of being retired. Nor, given the current economic climate, are many investors eager to build new theaters.

So, at about $1,500 per physical print, the early digital-cinema adopter will need to show about 100 prints before breaking even. Assuming the exhibitor turns over titles every two weeks, it will take four years to receive a straight, cash-on-cash payback—discounting loan interest and other incidentals.

No one in the exhibition business, including Anschutz—which owns the Regal, United Artists, and Edwards chains and the Qwest fiber-optic network—will invest that kind of money so that a distributor can make a larger profit. Investing $10 billion in a global retrofit will provide few benefits to the five media companies that dominate the entertainment industry: Sony, Fox, Universal, AOL Time Warner, and Viacom. All of these companies currently stagger under mountains of debt and the unkind assessments of equity markets—which makes them unlikely to take on more debt for a dubious return. Besides, working together to support the implementation of digital technology presents these companies with a legal challenge because of potential antitrust issues. They also face a cultural challenge given the fierce rivalries that have arisen historically between these intense competitors.

Worse, current theater owners have no compelling reason to switch from film—and won't, until digital cinema makes enough of a market penetration to provide a competitive incentive for the upgrade. Various third-party solutions have surfaced—such as the current Technicolor/Qualcomm and Boeing ventures (http://www.qualcomm. com/digitalcinema/ and http://www.chron.com/cs/CDA/story.hts/ae/movies/jump/1214410)—but these provide only another variant of the same zero-sum game, dealing in an outsider. A vigorous third-party solution put forward by a nonmedia company with deep pockets might overcome the system's inertia, however.

Only fools rush in

Meanwhile, technological developments proceed at breakneck speed, with some companies already developing replacements for Texas Instruments' digital micromirror devices. JVC, for example, created the direct-drive image light amplifier (D-ILA), which will cost around $25,000, to compete with TI's product. Likewise, Silicon Light Image has developed the grating light valve (GLV), which uses a single vertical linear array of about 1,080 chip-scale ribbons of reflective aluminum that can be bent using electrostatic forces generated on the chip. Both D-ILA and GLV are CMOS technologies, but GLV uses lasers and thus might be even more cost-effective than D-ILA (http://www.xilinx.com/esp/dvt/collateral/digital_cinema.pdf).

These rapid advancements are, ironically, slowing adoption of existing technology. No one wants to buy equipment now that will cost 85 percent less in a couple of years—a pattern well established by digital-domain products. Waiting seems an especially sound strategy considering that no one has proven that upgrading to digital cinema can generate even one dollar of revenue.

THE HOME FRONT

Although economics make digital cinema's immediate adoption unlikely, no factors inhibit the application of digital technology to home entertainment—specifically, studio-sponsored entertainment-on-demand (EOD) systems. For example, AOL Time Warner, which owns Warner Studios, began deploying EOD this year via its Time Warner Cable business. Using EOD, consumers can call up a menu of TV shows and movies, select a program to be displayed on their home set, then perform functions on it similar to those found in a VCR, such as reverse and fast-forward.

Better than theaters

Increasingly affordable technology will soon make the home viewing experience superior to watching films in a theater. As more consumers buy large televisions and Dolby 5.1 sound systems, home theaters will become common. The decreasing cost of large-format displays, which has been dropping rapidly in reaction to plummeting LCD projection costs, can only accelerate this trend.

Moreover, cable services now provide digital and high-definition television to all major US markets. The US Federal Communications Commission has also stuck to its mandate that all television broadcasters must provide HDTV service by 2006. The convergence of these developments will create a fully digital home-entertainment experience.

The human factor

These advancements do not, however, address the underlying social issues that will cause the multiplex to remain attractive long after home theaters have outstripped them technologically. The core audience for theatrical films consists of teens and young adults, for whom this form of entertainment operates as a mating facilitator. These young people usually don't live in a place large enough for a home theater, unless they're still living with their parents.

Further, to socialize freely with their peers, young people must leave home—either to avoid intrusive parents or, as they mature, roommates. They need a neutral terrain for their social engagements. Sitting in a room with a large number of strangers all facing forward lets them avoid actually conversing for an entire evening—thus providing an ideal means of postponing the awkward interaction that often accompanies first dates.

The multiplex will not die, no matter how sophisticated home systems become. True, people may spend more time cruising the malls, surfing the Web, or prowling chat rooms than they do hanging out in movie theaters. Yet, going to the movies will remain a fixture in our society's experience—one that digital cinema will surely enhance, eventually. ■

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