Digital Cinema: Opportunities and Challenges

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Abstract: While the process of distributing and exhibiting a film has changed a little over the past century, Digital Cinema, the process of using digitally stored data instead of strips of acetate, has arrived. With technology continuing to develop, it is expected that d-cinema will overtake the quality of conventional cinema has within the next two years. This paper considers how the film industry might effect the transition from film to digital products.

Rather than contributing to the continuing debate about the qualities of the competing technologies or the creative merits or demerits of digital product, this paper focuses on the search for new business models in an industry wedded to an analogue process. It considers; the strategues of implications associtated with change; and how different territories might adapt in order to accommodate to this transition.

1.1 Introduction

The distribution and exhibition of motion pictures are at a crossroads. Ever since the medium was invented in the 1890s the 'picture' has been brought to the spectator in the form of photochemical images stored on strips of celluloid film passed in intermittent motion through a projector.[1] Now at the beginning of the 21st century, an entirely new method has emerged, using digitally stored data in place of film and barely needing any physical support other than a computerised file.The technology now exists to shoot, edit, distribute and exhibit a movie entirely digitally and the pace of change is increasing rapidly. In both Los Angeles and London, digital cinema testbeds have been established to allow manufacturers and others to evaluate technologies and provide demonstrations. With technology continuing to develop, it is possible that d-cinema will

equal the quality of the best conventional cinema has to offer within 1-2 years. Already to some expert eyes[2] there is very little to choose between a good 35 mm release print and the digital projection in flagship cinemas.

The traditional photochemical process of analogue movie making is capable of producing images of great beauty and expressive power. While some are not yet convinced that digital products can match the quality of their analogue counterparts, for the majority of movie-goers this will not be a convincing argument. The traditional viewer experience is often diminished by the use of third generation (release) prints manufactured on high speed printing machines, and by the wear and tear of a mechanical exhibition process that results in them frequently being scratched, dirty and faded, resulting in a degraded presentation[3]. In any case, prints are bulky and their manufacture, distribution and exhibition are labour intensive.
Furthermore, in a world ever more pre-occupied with the impact of industry on the environment, the continuing reliance on a technology (film manufacturing) which involves environmental risks is harder to justify in the presence of a cleaner alternative.

Digital cinema has none of these drawbacks. Digital product permits non-physical delivery to the viewer and there is no need to manufacture prints unless we choose to. Where copies of an original are made, each is a perfect clone of the original and there is no deterioration with each subsequent showing. Because the movie is stored digitally, its physical size is no longer an issue and once loaded into the server and the movie calibrated, it does not require the attendance of the projectionist to do any more than start the show. However, for the moviegoer, concerned with the cinema experience rather than the technologies behind it, the outcome is that the presentation will be of exactly the same standard with each projection.

Distributing digital files should not only yield great benefits in terms of the clarity and quality of the image seen by cinema audiences, but also offer greater security for the distributor and more flexibility for the exhibitor. For example, it affords bestsellers easy

expansion to more screens and allows different versions of trailers to be matched to the demographics of a particular audience. A 'digital print' can contain multiple subtitled and dubbed language versions. Furthermore, the potential savings on the (at least) US$1 billion spent annually on manufacturing and shipping prints provide a powerful impetus for change.

From the filmmaker's point of view, digital technology has the advantage of preserving creative intent because all versions of the picture can be extracted from the same master with minimal adjustment. Furthermore, it may open up opportunities for independent filmmakers as costs reduce and barriers to entry fall. The possibilities thus offered by digital cinema have led to a surge in interest and information in recent years; however, much of this has focused on the technology, or the impact on the creative process, rather than the financial implications for the industry and the search for new business models[4].

This paper considers how the film industry might effect the transition from film to digital product. Using public sources to predict the eventual technological solutions which will prevail is problematic as no independent academic analysis appears to have been carried out. Technology companies are clearly wedded to their own solutions, pointing out flaws in competing technologies while downplaying the shortcomings of their own. Industry wide bodies that have been set up to promote d-cinema or establish standards, understandably tend to avoid taking sides and promote all solutions equally[5].

Rather than contributing further to the debate about the qualities of competing technologies or the creative merits or demerits of digital product, this paper will focus on the search for new business models in an industry wedded for over one hundred years to an analogue process. In the sections which follow it will consider: the strategies of the companies at the forefront of the technology; the financial implications associated with change; and how different territories might adapt in order to accommodate this transition.

1.2 What is Digital Cinema?

At present our working definition of d-cinema is 'the process of mastering a motion picture in digital form, distributing the digital file to cinemas (on fixed media, by satellite, or over broadband connections) and displaying the motion picture ('film' becomes a misnomer) using a digital projector'. D-cinema, then, involves placing onto a cinema screen an image that has been supplied as digital data rather than, as is presently the case, a reel of film. It should be distinguished from Digital Cinematography which is the process of recording an image digitally rather than on film stock. This definition currently excludes the production and post-production stages of movie-making.

We should not ignore the fact that digital cinematography is also developing rapidly and at the production stage there will be increasing opportunities for digital origination. Already Digital Video (DV) has come to replace 16mm film as the preferred low budget alternative to 35 mm, with the Los Angeles Film Festival seeing ten per cent of submissions on DV in 1999 moving to 60 per cent in 2001.[6] In post-production, where digital non-linear editing devices have been in use since the mid 1980s, digital dailies, previews and digital intermediate are starting to appear. Nevertheless, we can predict that for years to come, many or perhaps most mainstream motion pictures will continue to be shot on 35 mm film, and that it is in mastering, distribution and exhibition that the current d-cinema revolution is taking place.

The traditional process of taking a movie from the edit suite to the projection room requires that an interpositive be made from the original negative material and from this, an internegative is produced. The interpositive and original negative are then archived for security. It is from the internegative that all theatrical release prints are subsequently run. The costs and time involved in this process are significant; interpositives and internegatives cost between US$10,000 and US$25,000 each, whilst theatrical release prints cost between US$10,00 andUS$1400 each, depending on the quantity ordered.

For a large release it is not uncommon for 3000 to 4000 prints to be struck (even more for blockbusters), and each 1000 prints require a new internegative because of inevitable wear and tear in the printing process. These release prints are then sent out via freight or courier at a further cost of US$100 to US$200 each and, depending on final destination, several days delivery time.

With modern film marketing, the initial opening weekend figures are seen as the most important markers, and there is a relationship between the number of prints of a film released over this period and its eventual financial success. Too few prints and a significant proportion of the available revenue may be lost; too many and needless expense has been incurred.

Digital cinema will revolutionise this process. The digital master is created by capturing image information digitally, either from the assembled original film negative or from the interpositive, then final colour and other image adjustments are made digitally (as opposed to photochemically in the processing laboratory). The cost of making this digital master (sometimes called a digital intermediate) varies widely from US$25,000 up to more than US$150,000, depending on how much time the creative team spends making adjustments. This cost can be expected to come down considerably as more competition and faster hardware appear in the marketplace.

For traditional release, during the transition period while prints are still required, the process of digital mastering offers a related advantage. In place of the traditional original negative-interpositive-internegative-release print process flow described above, the completed digital master can be converted into a negative through the film recording process, where the digital data is written into film negative stock. Print quality is significantly enhanced because each negative made from the digital master is in effect an “original negative,” i.e., first-generation rather than third generation as is the case with the traditional internegative.

For digital cinema release, the digital file is then encoded in a selected compression scheme and transmitted in one of several possible ways direct to the cinema where it is stored on an appropriate medium until it is played through a digital projector. Because the motion picture is delivered and stored as digital data, transit charges are significantly reduced and expensive print costs are superseded by cheaper digital equivalents. The number of copies becomes irrelevant; providing that an appropriate medium is used, it is as easy to send the movie to a thousand cinemas as it is to send it to one. Furthermore, digital cinema insures against the possibility of opening with too few or too many prints as the number of screens can be adjusted daily rather than weekly, subject to contractual considerations.

2.1 The Development of D-Cinema

Image quality alone is not sufficient reason to trigger the transition from film to d-cinema; this is merely a prerequisite for serious consideration. There are other advantages over film; the shape and colour of images can be transformed with more precision, and elements from both original cinematography and computer generated imagery can be seamlessly composited. Digital technology also makes the product less vulnerable to piracy as the digital file will be encrypted and decrypted for validated users using the appropriate keys.

However, the most important consideration is financial savings and it is this that will ensure that d-cinema will predominate. For d-cinema to be successful any savings must be made throughout the distribution and exhibition chain, as it is highly unlikely exhibitors would be amenable to incurring the expense of new equipment if only the distributor will gain.

D-cinema has been anticipated for nearly a decade but recent technological advances have led cinemas worldwide to install digital projectors on approximately 165 screens, about half of them in North America[7]. Groups have been set up by the National Institute

of Standards and Technology (NIST), the Motion Picture Association of America (MPAA) and the Society of Motion Picture and Television Engineers (SMPTE) in the USA, and the European Commission in Europe, to promote the best way forward[8] Significant factors that remain undecided are: at what rate will this change be effected globally? And who will be the eventual financial beneficiaries within the industry? Whilst some companies have taken steps to promote their own solutions to the conversion, it is the major Hollywood studios that possess the financial clout to make the final decision on the pace of change.

2.2 The Implementation Path

There are other factors that will hinder or promote the change. Different countries or regions may have different strategies associated with the roll out. The involvement of the European Commission and equivalent bodies in other regions in adopting standards may prevent a system that works in the US from being deployed wholesale into other cinemas world-wide, possibly delaying the process[9].

In examining the way that d-cinema is likely to affect the industry, three areas of technology development emerge as being of fundamental importance to its final implementation:

1) Digital projection systems
2) Digital data compression
3) Transfer of product from editing suite to projection room

The following sections examine these in turn.

2.2.1 Digital Projection Technology

There are five main contenders in the race to develop a new projection technology as shown in table 1.

Table 1 The Development of Digital Projection Technology

Projection technology	**Backers & Interested Parties**	**Development status**
Digital Light Processing (DLP) using Digital Micromirror Device (DMD) technology[10,11]	Texas Instruments, Barco, Christie Digital, Digital Projection/NEC	In operational use in 165 cinemas, half in the US the rest in Europe, Asia and Latin America[12]
Direct Drive Image Light Amplification (D-ILA)[13].	JVC, Kodak	At prototype stage, not yet commercially installed in cinemas (in operational use elsewhere). Launch due during 2003/4[14]
Grating Light Valve (GLV)	Silicon Light Machines[15] and Sony Corporation	Still at prototype stage, has not been installed in any cinemas. No launch date as yet
Silicon X-tal*1 Reflective Display (SXRD), a liquid crystal display (LCD) device[16]	Sony	Consumer market first, no launch date as yet for cinema
Laser Cathode Ray Tube (L-CRT) based on technology currently used in monitors and televisions	Principia Optics[17]	No cinemas have been installed with this technology

DLP technology has a significant advantage over the other types because it is available now and has proven to be reliable. The quality of images created with the first-generation 1280 x 1024 chip are considered to be particularly vivid and to approach that of a "show print" (the highest quality release print, made with extra care and at a higher cost). The second generation 2048 x 1080 exhibits even higher quality.

D-ILA, GLV, and SXRD technology have a significant unknown in that cinema products have not been produced and their price point has not yet been set. If either can be cost engineered to a price that is more acceptable to the cinemas (for example US$50,000) this might give them a competitive advantage to counteract Texas Instruments first to market dominance. However, Texas Instruments and its licensees can be expected to compete vigorously on price in order to maintain their market position.

Analysis of the five solutions shows L-CRT is the technology least likely to succeed - lack of big industry backers presents a barrier to its entry that is unlikely to be surmounted. While D-ILA, GLV, and SXRD are backed with the financial resources to finance development, DLP has clear competitive advantages in its first to market status. If TI manages to roll out the next stage of its strategy before either D-ILA, SXRD or GLV is brought to the market, then it may create the momentum to carry it into cinemas world-wide.

2.3 Digital data compression

D-cinema is faced with a problem of how to store data. Film negative can store a very detailed image easily on a single frame of 35 mm film, whereas to do the same digitally requires a vast amount of storage space. For example, a single frame image digitized at Cineon 4 K format requires 76.5 MB. Today's digital masters, made at HDTV, or somewhat less than 2 K quality, are typically less than 2 TB in size for a two-hour movie. If the industry adopts a 4 K standard, the size of the digital master could rise to 8 to 10 TB, a storage capacity equivalent to more than 200 new home computers. It is clearly impractical to send to cinemas and store a file this size for every movie, so compression is required for the d-cinema release.

To be considered seriously the form of compression used must satisfy three key criteria a) it must be able to compress the data down to a manageable size; b) it must be 'visually lossless' that is, none of the quality of the original image must be lost when the image is reassembled; and c) it must be non-proprietary so manufacturers can compete on the basis of price and quality, or, if proprietary, the owner must agree to make the standard sufficiently open that competitors can freely compete with the owner.

Most forms of compression proposed are based on one of two underlying technologies. The first is Discrete Cosine Transform (DCT); these include different levels of MPEG[18] (advocated by the Moving Picture Experts Group, part of the International Standards

Organisation) and its variants, such as Qualcomm's Adaptive Block Size Discrete Cosine Transformation (ABSDCT)[19]. At current resolutions both ABSDCT and MPEG can store a full movie on two 36 GB hard drives and when resolution is increased, it would be expected that the storage capacity of hard drives would have increased proportionally[20]. The second is wavelets, the basis of proprietary schemes, such as Quvis' Quality-Priority Encoding, and the forthcoming JPEG2000. Whichever scheme is adopted as a standard, it must provide visually outstanding images without visible spatial or temporal artefacts.

2.4 Transfer from the editing suite to the projection room

Once the editing of an analogue movie has been completed, an interpositive and internegative are made from the original negative prior to release prints being struck. As with any analogue copy some image degradation occurs, although strict quality checks are made to ensure that this is kept to a minimum. This is analogous to making a photocopy of a photocopy, where we would expect colours to lose some of their vividness and edges their distinction. In digital cinema the conversion to digital is made from the original negative or interpositive, meaning that the stored data is as close to the original version of the film as possible.

Presently once release prints are struck they are sent out via courier or airfreight and because of their size and weight (typically 25kg), their distribution is expensive. Coupled with the cost of shipping the prints, the cost of acquiring multiple prints can become prohibitive. Hence to reduce their costs many countries purchase used prints and this can create a significant logistical problem. The availability of used prints is dependant on two factors: the number of new prints that were struck and the release dates of both the new print exhibitor and the used print exhibitor. Used prints can obviously not be supplied before the new prints have been exhibited, and once the new print exhibitor opens a movie it would expect to have the prints in the cinemas for a minimum of two to three weeks. After this period the demand for these prints can be

expected to decline. However, of the prints that have been used, a proportion will have been damaged beyond repair; so, if a movie is released on one thousand prints, approximately a third will be written off. As demand for the movie declines, damaged prints will be discarded in favour of prints that are still usable. Consequently, used prints will not generally be available until at least a month after release and possibly more.

Therefore, although a film may be expected to be a summer blockbuster, it is not always feasible to open the film during the season in both the new print territory and the used print territory. Furthermore, contractually many countries are not allowed to open a film before the USA. If a certain territory is allowed to open significantly before the USA, demand on the available used prints from other territories that show them will be high (normally far exceeding the available prints) as they try to release the movie as close to the USA release date as possible to avoid parallel importation or piracy.

Digital cinema reduces the cost of production of multiple prints, eliminates the need for used prints and provides a solution to the problem of delivery. Once the movie has been transferred into digital form, it can be copied quickly as many times as is necessary. The medium through which digital cinema is distributed is integral to the technology's evolution. Digital movies that have been projected so far have been supplied primarily on DVD[21]. DVDs can be reused once the movie has been loaded onto the projector's hard drive, without any loss of quality, as many times as required.

The provision of the movies on DVDs reduces the cost of transport. Approximately 25 films can be transported for the same cost as one print, and with an increased number of cinemas using the technology the cost per DVD reduces, enabling each movie to be supplied for considerably less than US$100. However, using DVDs to distribute movies is effectively substituting one physical medium for another. Films will still take several days to be delivered from studio to cinema and there will still be countries that will try to reduce their costs by acquiring used DVDs .

If the movie is transmitted by non-physical means to the theatre, d-cinema increases its advantage over conventional cinema. The movie can be delivered as quickly to a cinema in Russia or Japan as to one in Los Angeles. Furthermore, physical delivery no longer contributes to the cost and the sole charge is that of the data carrier. There are two possible solutions:

i. Satellite technology

This technology has proven itself in millions of homes for the delivery of satellite television as well as business-to-business data delivery. Satellites are a transmission medium that sends the digital data to anyone who has the capability to receive. It can transmit to anywhere in the world and once set up, incurs little further expense beyond transponder cost. Recent advances to satellite communications and telephony have also made the possibility of narrowing down the area of reception to a smaller (5-mile) radius rather than an area as large as the satellites capacity. The channel required to transmit movies for a year can be purchased for a few million dollars[22], comparable with the print costs of one movie. Transmitting a movie via satellite does require a larger antenna than that of the normal home receiver but it is still comparatively small.

ii Terrestrial Broadband

Terrestrial broadband is fed through fibre optics (normal telephone lines are not sufficient at the required data rate) and has also proven to be reliable. Like satellite transmission, terrestrial broadband can accommodate the requirements for the delivery of a d-cinema movie to a cinema on a DS3[23] line and current costs are approximately US$4000 per line per month, which could reasonably be expected to drop over time. In contrast to satellite, terrestrial broadband is a point-to-point transmission, meaning that only the intended recipient receives the message.

Although both media have the capability to provide movies to cinemas, satellite has

several important advantages. Its ability to be transmitted and received worldwide by the installation of a standard cost satellite dish wherever there is a cinema is important. Terrestrial broadband by contrast is easier to install in major western cities where the technology is already present, but further afield, even to outlying cinemas in western countries, the cost of installation to these regions becomes prohibitive unless heavily subsidised. Although the cost of line rental to a cinema in central Africa, Asia or South America can be expected to drop, these regions could not reasonably be expected to have the capability installed for at least a decade, whereas satellite receiving could be set up very quickly.

The one distinct advantage that terrestrial broadband has over satellite is its point-to-point transmission, which makes it less susceptible to piracy; however with encryption and other developed anti-piracy methods this should become less of an issue. It is not hard to predict satellite's lead, though if hacking or piracy prevention methods do not prove sufficient to safeguard the content, terrestrial broadband may be able to acquire a proportion of the market once it has sufficient infrastructure in place.

Whether satellite or broadband is used there will undoubtedly be costs incurred in creating the additional capacity needed in order to carry in the increased traffic. When these are factored into the equation some of the optimistic projections of massive savings brought about by the introduction of digital distribution may have to be revised.

3.0 Financing Digital Cinema

3.1 Print costs

The immediate justification for d-cinema is the elimination of print costs. A large blockbuster release in North America will use around 6000 prints. At US$1000 to US$1200 per print (and more in Europe[24]) this will add up to US$6.2m, a significant cost, to the distribution of one movie. For the North American film industry, with

approximately 200 releases among the major studios over the course of a year and assuming an average of 3000 prints, this totals US$600m. If other countries are added into this equation, then even with the allowance for a majority of smaller territories taking used prints the figure rises to nearly US$1billion.

There are approximately 35,000 screens in North America[25] and 115,000 across the rest of the world. Using the current cost of Texas Instruments DLP cinema projector (US$100,000) and factoring in an extra ten per cent for the installation of storage area networks, servers, satellite dishes, hire of satellite channel time and digitisation of the movies, a North American operation could be recouped in under seven years and a global rollout within fourteen, but only if 100 per cent of current print costs are eliminated in digital release. Since that is not realistic, a 50 per cent cost reduction would double the recoupment time. A reasonable estimate lies within these extremes.

However, this represents a worst-case scenario in terms of per-screen costs. If the cost of the system drops by 50 per cent and if digital release costs drop to only 25 per cent of current print costs, then recoupment occurs within four years in North America and six years worldwide, resulting in annual savings per studio in excess of US$100m.

3.2 Piracy

Estimates for the amount the global film industry loses each year to piracy range from US$2 to US$10 billion. The MPAA estimates that its member companies lose between US$3 and US$4 billion annually due to piracy but this does not include potential losses due to online piracy[26]. D-cinema cannot possibly hope to end piracy but it does represent an opportunity to reduce this amount significantly.

Most piracy takes the form of copying a film onto digital cideo for circulation during the interval between first release of a film and its arrival in a subsidiary market. There are two ways of combating it. One is to ensure that the original is well encrypted so that

a pirate copy either cannot be made or will show tell-tale signs of its illegitimate origins. The other is to shorten the period during which piracy is most lucrative by, for example, releasing new films in all major markets simultaneasouly.

Movies are generally pirated within days of a release. This is normally done either by illegitimate copying, someone taking a video camera into a legitimate screening or a projectionist being paid to run an extra show during which a video camera is set up[27]. In countries like China where the legitimate importation of foreign films is still highly restricted, piracy accounts for 100 per cent of the home video market.

It is possible to mark film prints such a way that illegitimate video copies can be traced back to the print from which they are taken, the process is hard to police and by the time the illegal act has been traced the harm has already been done. With digital, encryption is easier and can be done in such a way as to make copying impossible in the first place. If as a result the income lost to piracy were to drop by a third this would approximate a saving to the studios equal to that expected on print costs.

3.3 Worldwide releases and parallel importation

Partly in order to combat piracy, the industry has recently moved to accelerate the release of films in subsidiary markets and in many cases to release films worldwide on the same day. This follows experience such as that with *The Blair Witch Project,* which was released theatrically in North America on 30 July 1999 but did not reach the UK until 29 October, by which time it had done three months business in the USA and even (on 22 October) released there on DVD. By that time thousands of copies were already circulation in the UK on video or via the Internet, damaging the film's box-office prospects considerably.

Simultaneous release in all markets removes the problems associated with used prints, but it also increases costs, since more prints have to be made. With d-cinema, where the

cost of a ‘print’ is minimal, this extra expenditure is no longer needed, makin simultaneous release a much more viable option.

3.4 Staffing

Simultaneous release also makes possible a singe, concerted global marketing campaign for all markets, which can have advantes given that advertising costs for major releases are often equal to, if not greater than, print and distribution costs. In practice, however, advertising that works well in America may be judged ineffective for, say a Japanese audience. Even if savings could be made, they would not radically diminish the enormous spending that companies would still have to make in promoting major releases.

D-cinema offers the opportunity to reduce staffing costs. Once roll-out is complete and traditional film projectors become obsolete, then the need for projectionists is removed. Whereas film is labour intensive requiring it to be made up onto reels, laced up in the projectors prior to screening as well as focused and racked (ensuring the whole picture is shown and black bars do not appear at the top or bottom), digital technology does not require this. Once a film is loaded onto a server connected to a projector (either with a physical medium or by terrestrial broadband or satellite) then the only input from the cinema is the information on when the screening should start. Because nothing on the projector moves once the projector has been calibrated it remains in focus and rack, with maybe a weekly or monthly maintenance check. Films are effectively delivered pre-made-up and the digital equivalent to lacing the projector is accomplished by pressing a single button or having the system automated. On the few occasions that a problem is experienced a manager, who would, in any case, be on hand to deal with the day to day running of the cinema, should be able to rectify any problem through the methods that are currently used, that is, restart or continue a show, move the audience to another screen or offer a refund. Assuming an average projectionist’s salary of around £20,000 per annum in the UK, the elimination of this cost could mean a saving of tens of millions of dollars to exhibitors, increasing the viability of cinemas.

3.5 Other events

A digital cinema is significantly more versatile than a conventional cinema. The technology exists that can allow a cinema to receive and project a high-definition program television program in real-time. Consequently, the cinema could exhibit events such as live sporting fixtures, music concerts, business conferences or other activities[28]. Although in practice the volume of events open to this type of arrangement will vary according to the region and cultural habits, the idea does possess the potential to utilise some of the unused capacity of cinemas.

3.6 Funding the change

Digital cinema is a viable financial alternative to conventional cinema but its installation, despite the potential benefits shown above, will be costly. The worldwide rollout of the technology will not be immediate and despite having demonstrated to most, if not all, of the industry that the quality it can provide is at least equivalent to conventional cinema, it still has several barriers to overcome. A critical question is who will pay for it? Even assuming that the cost of digital projectors drops to a third of their current market price, the expense of introducing them into theatres in North America alone amounts to one billion dollars. Worldwide introduction would cost more than three times that amount.

With the greatest saving being achieved through the abolition of print costs, exhibitors are understandably reluctant to incur the costs of new equipment without a greater percentage of the ticket price being allotted to them. Similarly, distributors may consider that it is not their responsibility to incur the cost of equipment that they do not operate without some change in the allocation of the ticket price. A further problem becomes apparent with many studios being part of the same group that operate an exhibition chain. Most of the major studios have at least a majority stake in one exhibition chain; for example in the UK, Warners haveWarner Cinemas, Universal have

UCI, and Paramount Showcase/Hoyts. Supplying digital projectors to these cinemas alone could be seen by some as giving unfair advantage over, for example, the independents and attract the unwanted attention of regulatory bodies. A universal rollout of digital cinema would ameliorate this issue.

Technicolor/Qualcomm's intervention in this area [29] (proposed installation of 1000 DLPs across North America in return for a fixed fee per digital presentation ticket bought) received a negative response and it is generally perceived that the distributors/studios and exhibitors will eventually finance this change but on their own terms and at their own pace. However, independent cinemas may be more amenable to the proposal allowing them to acquire cutting edge technology without the financial burden of paying full cost, for example, the recent deal in the US between Landmark theatres, Digital Cinema Systems and Microsoft[30].

4.0 The Global move to Digital Cinema

4.1 North America

Despite the best efforts of companies who actively promote d-cinema the change will not occur overnight. However, what is clear is that global change will be driven by the USA. Although it accounts for less than 10 per cent of the world population the USA domestic market accounts for nearly a third of all screens and over half of all box office takings worldwide[31].

4.2 Western Europe

Western Europe (including the UK, France, Germany and a dozen or so other countries) is the most important regional market outside of the USA. But it is a ‘single market’ only in the sense that there are no tariff barriers within it. For the rest it comprises a number of individual countries with their own censorship or classification systems and a variety of different languages into which imported films may need to be dubbed. Moreover each individual country, and European Union in general is engaged in promoting its own interests, which may or may not be harmonious with those of the USA and the major studios. Thus, the Minutes from the UK's Electronic Cinema Group contain such comments as '*Europe should be very wary of accepting their [USA] routes'*, although on the other side the European Digital Cinema Forum (EDCF), a user group made up of business, content, and technical experts largely from the private sector, has made a consistent effort to work in concert with its USA counterparts and to look for areas of agreement. (For a fuller account of EU initiatives in the d-cinema field, see Anna Herold’s article un this issue of Convergence).

Another difference between the USA and Europe is the latter’s inability to support a studio system on the Hollywood model. With American films taking up to 70 per cent of box office in many European countries and the American majors controlling major releases, Europe has tended to look to the USA-based distributors and exhibitors to fund the installation of d-cinema. Provided technical standards can be harmonised, Europe is likely to support a rollout of digital cinema installation conducted by the majors, if and when it comes.

At the same time, Europe is fiercely protective of its own cinemas, many of which produce mainly medium and low budget films for limited release, independently of the USA companies, and has its own reason for promoting a conversion to d-cinema. The UK Film Council, for example, issued the following announcement on 22 July 2003:

> The UK Film Council's Lottery-funded Distribution and Exhibition Fund has today announced that it is embarking on a new Digital Screen Network to increase the opportunities for audiences to see specialised and 'art-house' films. £13 million will be invested in setting up 250 digital screens in approximately 150 existing cinema sites around the country (over a quarter of UK cinema sites) showing a broad selection of films which could never before gain the wider distribution that is now possible using efficient digital projection and delivery. Money will also be spent in ensuring the creation of cost-effective digital copies of films so that film distribution companies can maximise the audience opportunity offered by the circuit[32].

In return for providing cinemas with this technology, we can expect that the UK Film Council will seek to earmark a certain proportion of screening time for showing specialised films, which to date have had limited opportunity to be seen outside London and other major cities. Meanwhile, the very diversity of the European market provides a further stimulus to the introduction of d-cinema in that digital formats can support different language tracks without the need make different sets of prints for each language region.

4.3 Japan

A major factor affecting the implementation of d-cinema is the Japanese preoccupation with obtaining the most up-to-date technology as soon as it comes to the market. This suggests that once the facility is available for all movies to be supplied in digital format Japan will be the first country to adopt d-cinema fully. Further, as two of the manufacturers of digital projectors (JVC and Sony) are based in Japan, it would be reasonable to predict their swift introduction in order to promote their products.

As the world's second largest economy, Japan is a key territory. The country has a comparatively small number of screens but this belies its screen average figures (the income generated per screen per week), typically ten times those of their western counterparts. After North America, Japan is one of the three most important territories, and due to regional viewing differences films that perform indifferently elsewhere frequently do well at the Japanese box office. Compared to other western countries that rely on most of their content coming from Hollywood, Japan also has a thriving indigenous industry. Japanese films frequently constitute half of each weeks top ten grossing pictures, compared to France and Germany, which struggle to hold 30 per cent, and of the Japanese product a significant proportion is animation which lends itself to d-cinema.

4.4 China

China has a network of approximately 60, 000 screens[33] (3100 official cinemas, 40,000 city and village halls and around 12,000 mobile projection units) already in place. In the context of d-cinema only the official cinemas are of interest, although as specified below the funding opportunity may be available to convert a significant volume of the other projectors as well.

Despite its potential China is an underdeveloped territory and until its recent entry into the WTO, which has provided the entry opportunity to the Hollywood studios, had been considered a write-off. Prior to its entry China agreed to sign up to support copyright and intellectual property rights which had previously been a stumbling block to its entry and a significant contributor to the high level of piracy in the country[34].

Combined with the above agreement, d-cinema with its anti-piracy defences could provide the ideal way for studios to protect their product in this, their most vulnerable territory. News Corp. (the owners of 20th Century Fox), Warners and other media companies have demonstrated that successful joint ventures can be formed providing

that they are approached properly, and with proper representation to the Ministry of Radio, Film and Television (MRFT), the Chinese regulatory body, the introduction of d-cinema could be state-backed.

China has strict policies regarding the repatriation of revenues from the exhibition of foreign movies, allowing a maximum percentage that is far below that of other territories (for *Mickey Blue Eyes* Universal received a maximum of less than 20 per cent of all gross box office receipts whereas Disney obtained 33 per cent under a revenue-sharing agreement for *Toy Story* but was forced to incur all administrative and advertising costs). China also actively encourages high-tech industry through the allowance of tax breaks and incentives.

With careful negotiation, therefore, funding for the implementation of d-cinema could be released by the revenues from films shown, under the auspices of the introduction of new technology. This would allow the studios to maintain their proportion of the revenues whilst effectively prompting the state to finance the introduction of d-cinema.

4.5 Asia and the Far East

The Far East, covering territories such as Taiwan, Singapore, Hong Kong and Korea suffers most of the disadvantages of China and most of the advantages of Japan. Although Singapore has had some success in reducing piracy, it is still prevalent over much of the rest of the region. Many restaurants in Taiwan show the latest Hollywood blockbusters on televisions at the table, often before the film has been released in the territory. D-cinema represents an opportunity to reduce a significant proportion of the piracy that occurs.

On the positive side, despite the current downturn in the region's economy, the Far East is technologically progressive and well suited to adapt to d-cinema, although who will fund this is less certain. The region represents about 8 per cent of the total world

theatrical market but significantly less than that (about a third) is Hollywood product; as such, there is little incentive for the studios to finance the cost of equipment that would, for the majority of the time, not be used to show its movies. However, deals between USA owned exhibitors might provide the initial catalyst that will cause the region to fund its own implementation.

4.6 The rest of the world

The rollout of d-cinema to the rest of the world will take place over a far longer period of time. With the exception of major metropolitan areas (such as Buenos Aires or Johannesburg), small numbers of cinemas and box offices that contribute only fractionally to the international revenues do not make the conversion of these regions a high priority. The rights to distribute a movie in some territories can frequently be bought for less than the cost of a digital projector.

The factor that will contribute most to the implementation of d-cinema across these regions is likely to be the lack of availability of used prints once the major regions (USA and Europe) convert. Even if supplied at cost new prints are approximately twice the price of used prints and small or poor territories will be unable to justify the expense. This has a number of implications;

a) Movies might become so expensive to distribute that only the largest blockbusters (films that can be guaranteed a return) will be released in smaller territories; this will result in even fewer home grown films as the profits from the blockbusters are spread thinner to cover costs on indigenous product.

b) Distributors or exhibitors in these smaller countries may be required to incur the costs of replacing their projectors themselves.

c) Consolidation may take place within the territories in these regions to allow

companies to become big enough to finance the installation effectively.
In reality a combination of a, b and c is likely to occur as increased links are made between the distribution and exhibition sectors and the territories' struggle to survive.

5.0 Conclusions

There is little current agreement between the parties about the way forward. Companies offering technology cannot push this evolution forward without approval from studios and exhibitors. This is because unlike previous innovations in cinema like SRD sound, acetate/cellulose film, or 35 and 70 mm formats, digital cinema is not compatible with conventional cinema technology. The two are mutually exclusive. A dual-purpose projector is not planned, and although in flagship cinemas there is the capacity and capability to have both running side by side, in the majority of cinemas there is not. This means that before d-cinema is rolled out across a larger number of screens it will have to be fully supported by all of the studios in order for them to provide product to the cinemas.

Global standards will be set and they will originate, unless other territories fund the conversion themselves, in the USA. Unlike technology such as television or computers, the market of d-cinema is not large enough to support more than one standard. Furthermore, multiple standards would require multiple inventories, and a primary advantage of film – one standard, namely 35 mm – would be lost. As the source of funding in the industry, certain studios have been involved at an early stage and their decisions are likely to be significant. Territories such as Europe which are trying to follow their own path run the risk of being forced to change direction as their position becomes increasingly untenable without direct government involvement.

In North America, Western Europe and Japan some combination of the studios and exhibitors will be required to fund the change. Therefore they are likely to have the final decision on any particular aspect of d-cinema and will determine standards. It will be

uneconomic for others to establish alternatives.

The cost of the technology, specifically projectors, must fall. Currently a digital projector would require around ten years to be written off. Studios will wait for the cost to fall to a point where they can write it off over perhaps three to five years. Both time and competition are likely to remedy this.

D-cinema will require less human input into the running of a cinema. In theory the potential of technology could allow a cinema to run automatically, with internet bookings and ticketing, vending machines for refreshments and a system of screening the film that is run from a central control centre. In practice employees will continue to feature in the "front of house" running of cinemas if for no other reason, to intervene if the system goes dark. However, backstage less labour will be required and the role of projectionist may be taken on by managers.

Acknowledgements

The authors would like to thank Charles S. Swartz, Digital Cinema Laboratory at the University of Southern California, Los Angeles, USA and Andrew Boucher, Capitol Films, London, UK for their contributions on the drafting of this paper.

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