DIGITAL AGENDA FOR THE EUROPEAN FILM HERITAGE

CHALLENGES OF THE DIGITAL ERA FOR FILM HERITAGE INSTITUTIONS

Final Report

prepared for the
European Commission, DG Information Society and Media

December 2011

This Study:

Main tenderer:

Subcontractors:

The Final Report was edited by
Nicola Mazzanti

Disclaimer: The opinions expressed in this study are those of the authors and do not necessarily reflect the views of the European Commission

Table of Contents

1. Foreword

1.1 The Study's Goals

Twelve hundred feature films were produced in Europe in 2010, with almost 1 billion admissions amounting to nearly 6.5B€ in box office receipts alone, not taking into account sectors such as home-video, cinema on TV, and Video-On-Demand (VoD) that still represents some two thirds of revenues for film productions. On European TV channels, cinema amounts to 35% of all fiction content[1]; cinema films takes 62% of all viewing time spent on pure VoD channels (as opposed to broadcasters' VoD channels)

We can thus conclude that cinema is still high in terms of consumption across devices and distribution channels:

> "When we take into account films on DVD and TV, Britons spent 7551 million hours watching films in 2008. This is 2.4 per cent of available time for work and leisure and 3.7 per cent of available leisure time.[2]"

These figures also show how European cinema continues to be a key component in the European media industry.

Over twelve decades, cinema has been and continues to be a key witness to our collective history and identity; the lens through which our past and our present can be watched, studied, enjoyed, and understood, the place for emotions, memories and dreams for whole generations of European citizens.

Undoubtedly, what a recent and comprehensive study concluded on the impact of cinema in British society can be extended to the whole of European cinema:

> The findings […] confirm that film has been a key arena in British cultural life, projecting and debating British values and identities, and remains potent despite the pervasive impact of television and US cinema[3].

An important component of the European media industry and an irreplaceable heritage of our culture and history, this is what cinema is for all European citizens.

Therefore it will not come as a surprise that the European Commission has taken the initiative to investigate how the advent of digital technology will impact the preservation of, and access to the European cinema of the past and of the future.

---

[1] Figures from the European Audiovisual Observatory for EU27.
[2] "Learning from some of Britain's successful sectors: An historical analysis of the role of government", by the Dept. for Business Innovation & Skills http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/10-781-bis-economics-paper-06.pdf
[3] "Stories we tell ourselves The Cultural Impact of UK Film 1946–2006 A study for the UK Film Council", 2009. http://www.ukfilmcouncil.org.uk/media/pdf/f/i/CIReport_010709.pdf

This study has as its objective to analyse the challenges and opportunities and to propose concrete, appropriate actions to make sure that Film Heritage Institutions (FHIs) across Europe are able to continue to fulfil their role in preserving the cinema of the past and that of the future, and to multiply ways by which they provide access to their invaluable collections.

This initiative of the Commission is undoubtedly as farsighted as it is challenging.

It is farsighted because the process by which European cinema is turning Digital in all its aspects – from production to exhibition, distribution, and access via innovative channels and services – is still largely ongoing. Nevertheless, as the study will highlight, this is the exactly the time when actions must be taken in order to avoid dramatic losses and to take maximum advantage of the opportunities offered to European culture and industry.

For the very same reasons, this is also an extremely challenging task. The transition is happening before our eyes, with Digital impacting and deeply modifying the whole landscape of media distribution and access in Europe, and reshaping the experiences and the expectations of all European citizens, with technologies for preserving and providing access continuously evolving at a growing pace but still struggling to keep the pace of a (r)evolution that is more about people's lives than about technology.

What the BBC defined in a recent initiative as the 'Digital Public Sphere' already exists in the minds of all European citizens, even though the cultural institutions (the legal, organisational, and budgetary environment) seem ill-equipped to respond to this demand for greater access to information.

This Study tries to investigate how FHIs can better respond to the challenge of providing more and better access, by keeping in mind that there is no access without preservation, and no preservation without collection. Hence, this study will look at the whole range of activities of FHIs and how these are impacted by Digital.

As defined by the Commission, the remit of this Study is to provide the necessary background information, analysis, and practical proposals based on which policies and strategies can be defined and implemented by the Commission, the Member States and the Film Heritage Institutions.

More specifically, the remit of this Study includes:
- To analyse in depth the challenges facing the FHIs
- To establish which kinds of legal/organisational/technical changes have to be introduced to ensure that film archives will continue to perform their role in the digital era
- To analyse the situation in the 27 Member States
- To analyse the situation in film heritage institutions in USA and compare it with EU-27.
- To describe the strategies of American majors and large European production companies for preservation of their digital films
- To provide feasible recommendations and a calendar to Member States and film heritage institutions on how to prepare for the digital era
- To provide policy options for EU action

The geographical scope of the study includes all Member States, covering hundreds of institutions regulated by different cultural, political, and legislative

approaches, differing in size, funding, and sometimes scope. Also, the study tries as much as possible to include in the analysis also the film preservation 'entities' in the private, commercial sector, as they play a significant and growing role in preserving and providing access to important parts of the European cinema heritage.

In order to better understand challenges, opportunities and potential answers to the many questions, the study also takes a very close look at other fields facing issues similar to those of the FHIs: audiovisual archives from broadcasters and data from space agencies. Current trends and activities in the United States were also explored and taken into account.

Summary

- European cinema continues to be a key component in the European media industry
- Cinema is both an important component of the European media industry and an irreplaceable heritage of our culture and history
- This Study has as objective to analyse the challenges and opportunities and to propose concrete, appropriate actions to make sure that Film Heritage Institutions (FHIs) across Europe are able to continue fulfil their role in preserving the cinema of the past and that of the future, and to multiply ways by which they provide access to their invaluable collections.

1.2 Defining the scope

1.2.1 The focus of the study

This Study focuses on the preservation of, and the access to European cinematographic heritage.

Within this study, 'cinematographic heritage' is meant to include all types of works produced for cinema distribution: feature films, documentaries, newsreels, narrative and non-fiction shorts, commercials, trailers, and so forth.

'Preservation' is intended both as preservation of the works of the past, conserved or not (yet) in a FHI, and the works that are being currently produced or that will be produced in the future, as they will all become heritage.

In this sense, the study does not focus on 'audiovisual' archives, where 'audiovisual' is meant to define collections of video and/or TV content (and so used within this study). Obviously, preserving and making audiovisual collections accessible is an endeavour of the utmost importance for European culture and history. Simply,

this is not the object of this Study because, as overlooked as it can be, the fact is that the two sectors differ significantly in technical issues, in the economic environment, and in the organisational structure of the bodies entrusted for audiovisual preservation.

1.2.2   The Film Heritage Institutions

The remit of this Study is to analyse the "legal / organisational / technical changes" necessary "to ensure that film archives will continue to perform their role in the digital era". In other words it implicitly acknowledges that FHIs play a critical role in preserving and providing access to the European cinema heritage.

In turn, the preservation of the European cinema heritage is seen as an element contributing to the competitiveness of the film industry, as stated in the "Recommendation of the European Parliament and of the Council on film heritage and the competitiveness of related industrial activities"[4]:

> *"Film heritage is an important component of the film industry and encouraging its conservation, restoration and exploitation can contribute to improving the competitiveness of that industry".*

With a history that starts as early as the 1930s, European FHIs have a long tradition of fulfilling the double role of preserving and restoring film heritage and contributing to European culture by making this heritage accessible.

European FHIs are a rather large and differentiated group. Some forty FHIs are members of ACE (Association des Cinémathèques Européennes), but many more are not as they are smaller institutions that might be less active at the international level.

Every MS has at least one 'national archive', and many have more than one institution the activities and impact of which can be defined as of 'national interest'. Furthermore Europe has a tradition of many regional archives (for examples in the UK or in Spain) carrying out critical work in collecting, preserving and making accessible works in a closer relationship with the local communities. Some of these 'smaller' archives have played a key role in the past couple of decades, being sometimes more active than larger institutions.

Many of these institutions are publicly owned (i.e., are governmental institutions at national or regional level) but many more have a wide variety of statuses as non-profit entities. Some are very large, with one hundred or more employees, but most of the larger institutions have some 50-60 employees, and the smaller can have as few as 5 or 6. Their budgets of course vary accordingly.

In short, the landscape of European FHIs is extremely wide and differentiated, but the aims, the goals and the activities of all these institutions are very similar, although the relative 'weight' of each activity differs from one institution to another, i.e. some aspects are more important than others for one FHIs.

As a whole, the European FHIs **collect** film on any support, of any type (feature films, animation, documentaries, newsreels, shorts, avant-garde, etc.) and non-film materials (books, journals, documentations, archives, photos, posters, etc.).

---

[4] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32005H0865:EN:NOT

Their collections grew over many decades and this study estimated that they can amount to 1M hours of cinema material (not including the non-film collections that are critical tools for the understanding and study of cinema culture in Europe over the past twelve decades).

This 1M hours represent most, if not all, of European film history, and European history through cinema. Although collections held by commercial and/or private entities are important and they should not be underestimated as they are particularly significant for specific segments of the European heritage, only the FHIs can provide a picture that spans over 12 decades of European culture, history and industry. It should also be mentioned that thanks to their acquisition policies, European FHIs hold extremely rare, and sometimes unique elements of foreign productions (mostly, of course, North American) that are often restored with their collaboration.

In the case of public non-profit FHIs, the vast majority of their collections consist of elements that are deposited with the FHIs; furthermore, it is extremely rare that FHIs own the rights of the works that are entrusted to them for the purpose of conservation in their role of cultural repositories.

FHIs actively **preserve** and **restore** these collections, and they have been doing this for decades, building up competences and skills that are unique, and that in most cases are superior to those found in the film industry. And in fact almost all of them collaborate with the film industry on a vast number of preservation and restoration projects, to the extent that it would be fair to say that the vast majority of restorations that were presented in recent years in festivals such as Berlin, Cannes, London, saw the involvement of one of more FHIs.

The importance of restoration and preservation for the European film culture and film industry is nowadays quite evident. Almost invariably, all major European Festivals have one or more retrospectives, and the home-video and DVD markets are literally inundated by 'restored' or 're-mastered' versions. The world's most important festivals dedicated to film history and restoration, showing every year hundreds of film restored in Europe and in the world, are in Europe (Pordenone and Bologna, both in Italy), and many of the most world-renowned film restoration laboratories are also in Europe.

All of these activities are based on techniques, practices, and theoretical and historical work that have been carried out by FHIs across Europe, with many 'centres of excellence' (in Belgium, Italy, the UK, the Netherlands, Spain, France and many others).

From the standpoint of their contribution to the European film industry, it is worth mentioning that FHIs activities in collecting, preserving and restoring are "countercyclical" (or at least cyclical-agnostic). As European FHIs tend to be publicly funded (differently from the US, where donations, sponsorships, grants and endowments play a key role), they continue performing their duties also when the industry cannot, or does not.

As a matter of fact, the history of FHIs can be seen in direct relationship with cycles of disinvestment from film heritage by the industry. Many archives were born as a reaction to the massive destruction of silent films when sound technology came about in the 1930s (many archivists see a parallel between the situation created at the time and the present digitisation of the film industry). Many others reacted

to the desire of the industry to reduce its exposure to the dangerously flammable nitrate material with which film stock was produced until the 1950s. The results of this desire were massive deposits of large collections into FHIs in Europe and in the US. Finally, FHIs played a key role in conserving film elements in periods when they held no commercial value after their theatrical exploitation. In fact, until the advent of cable television and most importantly home-video and DVD, in other words until the 1980s, cinema works terminated their commercial life after theatrical distribution, and became more liabilities and costs than "assets" for the industry. It is only from the 1980s that the situation started to change, and that the industry found interest in the 'old catalogues'. For the well-known reasons of weakness and fragmentation of the European industry, it was the US that responded first and more aggressively to this trend, gaining a 'competitive advantage' against Europe, where most of the restoration work that allowed European classics to return to the cinema and/or TV screens were in fact funded via the FHIs.

In this sense, the European FHIs did contribute heavily to the preservation and restoration of the European film heritage. Actually, it would be more precise to say that they were, and they continue to be, the primary actors in this field across Europe.

Last but not least, FHIs have been **providing access** and **exhibiting** the European Film Heritage for decades. Most FHIs have a regular activity of programming film series in theatres they usually own. This activity of exhibition includes not only the classics of film history, as FHIs often play a critical role in the diffusion of works that otherwise would not reach the audience. In both cases – the classics and the more recent productions – and thanks to a close collaboration, FHIs do contribute enormously to the diffusion of European cinema beyond each country's borders, as they constantly bring to the public European cinema of the past and of the present that would be otherwise ignored outside its country of origin.

Whole generations of European filmmakers, directors of photography, actors and producers received their cinematic education in the FHIs' theatres across Europe. Had the FHIs not existed, there would have been hardly any European cinema in the past six decades.

FHIs also provide access to their collections in many other ways, including on-site viewings, loan of projection prints to festivals and theatres; many produce and distribute DVDs; and some are starting an online presence. FHIs also serve different audiences. First of course are those who attend the programs and screenings in their theatres, the students, as many FHIs have educational programs, scholars and researchers who search the archives and use their collections.

According to the study's Survey, the second largest group accessing an archive's collection are the producers of programs and documentaries re-using archival footage. In all these cases, the FHIs provide not only the content but also the knowledge of the collections, offering a comprehensive service that contextualises and analyses in-depth the content of their collections.

All these activities are carried out also thanks to a long-standing and well-established network of collaborations among FHIs in Europe and in the rest of the world, with intense exchanges of cinema works between archives, with the circulation of

ideas, competences and techniques, with the participation in European projects like FIRST, EDCINE, MIDAS, EFG, Lumière, FAOL[5], and many more. Pivotal to these activities are the Association des Cinémathèques Européennes, and the FIAF-International Federation of Film Archives.

Summary

- With a history dating back to the 1930s, the hundreds of European FHIs are the guardians of most of the European Film Heritage, a key to the history and culture of Europe from the late 19th century.
- FHIs differ in size, mandate, legal statute, and resources, but they all share key activities: **collect**, **preserve**, **restore**, **provide access**, which they carried out for many decades.
- FHIs played and continue playing a key role in supporting the film industry in areas or at times when the industry is not interested in, or capable of, investing. This is the case with conservation and preservation, a service FHIs provided over decades when cinema works bore no commercial value, and with restoration, with most European films being restored thanks to, or in collaboration with the FHIs.
- Saying that all cinema works that were saved from oblivion and now find their way to new distribution channels were saved by FHIs is not far from the truth.
- European FHIs also hold a unique wealth of competence and skills in the preservation and restoration of cinema.
- The FHIs have a long history of providing access to their collections, in theatres across all of Europe. Whole generations of filmmakers were formed in those theatres.

1.2.3   The Film Heritage

If the FHIs are many and varied, so is the heritage they conserve and provide access to. As it was mentioned earlier, cinema collections include many forms of filmed materials. Although when thinking 'cinema' one has the tendency to associate it with feature-length fiction films, the reality is much more differentiated: newsreels, documentaries, commercials, trailers, shorts, avant garde and artists' works, they all constitute the European Film Heritage, and they are sometimes sought after even more than feature films.

Also the definition of 'heritage' is complex. FHIs collections range from the dawn of cinema (and often include 'pre-cinema' apparatus) to works produced literally today. On the other hand, it is important to differentiate, as there is a significant difference between a feature film produced in 2005 and a documentary from World War One. Works from different ages of film history pose different challenges in terms of conservation and preservation: nitrate base, highly flammable and unstable, was used until the 1950s, and large collections of

---

[5] FIRST-Film Restoration and Conservation Strategies, EDCINE- Enhanced Digital Cinema, MIDAS- Moving Image Database for Access and Re-use of European Film Collections, EFG-European FilmGateway, Lumière was a MEDIA project, FAOL-Film Archives Training OnLine.

unique materials exist in this format. But films on acetate, in use after the 1950s, are 'safe' in the sense of being flame-resistant but are subject to chemical degradation that make them as fragile as nitrate films. Finally, colour films from the 1950s onwards are subject to colour fading. Specific methods and techniques and an extensive knowledge of film history are required to conserve and preserve these different collections.

Different types of films and films from different eras also pose different challenges in providing access to. They need to be selected, contextualised, and programmed properly.

It is also not easy to define the potential interest, or commercial value of any of the films conserved by the FHIs. The interest on certain areas of film history changes, selection criteria are difficult to define and to apply. As taste and cultural interests evolve, a famous rule of factual footage houses stands true: *"the sale of 1% of the collection covers the costs of the other 99% - you just never know which 1%".*

It is also not easy to define an 'archival item', or a 'catalogue title'. When does a film enter the category of 'archival' and 'old'? Commercial exploitation of cinematographic works has traditionally been relatively short, ending with the theatrical distribution for many decades. Home-video and broadcasting lengthened the life-cycle of a work, but usually after some 5 or 6 years the revenues (if any) produced by a work are minimal.

Often quoted figures indicate that revenues for European feature films are roughly structured as follows:
- 60% of potential revenues in year 1: theatrical release.
- 20% of revenues in year 2: theatrical release in other EU countries and sale to pay-TV
- 10% of revenues in year 3: sale to non-pay TV
- 5% in years 4 and 5: home video and some further domestic broadcast
- After year 4 and 5 revenues are basically statistically irrelevant[6]

Obviously, this is statistics, and of course there are works with a much longer life than others, and this is particularly true that channels like DVDs and VoD seem to offer a chance of new life for many 'catalogue titles'. Unfortunately no precise figures exist about the potential revenues of catalogue titles, but it is rather clear that only a small percentage of the hundreds of thousands of titles that are held by European FHIs are commercially available, a clear indicator that these works are not expected to be commercially interesting for the rights holders. Once more, this is particularly true for non-fiction works (again, with some exceptions).

So, it is reasonable to consider that a work that is 5 years old is objectively part of the 'heritage'. This does not mean that it has no potential commercial value, but it rather means that in overall terms, i.e. in terms of the thousands of 'archival films' held by FHIs, only a fraction can realistically find their way into a successful re-distribution for commercial purposes. The vast majority have only a cultural, historical value, and might enjoy limited sales (e.g. on a VoD service) provided that they are made available, i.e. digitised. Except of course that digitisation comes at a cost.

---

[6] Figures from the study "Identification et évaluation des flux économiques et financiers du cinéma en Europe et comparaison avec le modèle américain IMCA for DG EAC, Unité C1, study nr. DG EAC/34/01

As for the collections themselves, access to collection and digitisation cannot be analyzed under only one model, as archival films are different, with different cultural and commercial *potential* values. And the emphasis here is on 'potential'.

1.2.4   The starting point

The study makes its analysis and its recommendations on the assumption that ***cinema is worth preserving for the future, and it is worth being given access to*** for cultural or educational uses, for commercial purposes, for pleasure, or for the European citizens to know their own history and culture.

Although a point could be made (and in fact it has been made) that cinematographic works are industrial products and as such they should not be the object of a public policy of preservation and access, there is strong evidence that this concept does not apply to the European context and tradition.

First of all, such a view is in contradiction with a vast body of legislation from all Members States, and from the European Commission, Council, and Parliament.

The "Council Resolution of 26 June 2000 on the conservation and enhancement of European cinema heritage[7]" emphasises how the cinematographic heritage

> *can play a decisive role in consolidating the cultural identity of European countries both in their common aspects and in their diversity. Citizens, in particular future generations, will, through the medium of these works, have access to one of the most significant forms of artistic expression of the last 100 years and a unique record of the life, customs, history and geography of Europe.*

Furthermore, the Resolution makes an explicit link to the economic value of the cinematographic heritage by stating that:

> *in the present climate of proliferating distribution channels which increase demand for new programme contents, this form of cultural heritage too is an important basis for creating new cultural products.*

Finally, it calls on the Member States to cooperate in many areas including "the restoration and conservation of cinema heritage" as well as "through recourse to digital technologies" and "the possible use of these collections for educational and scientific purposes".

The recognition that the cinematographic heritage has an enormous cultural value for Europe, and that it plays also a role in reinforcing the media industry, and as such it should be preserved, restored and made accessible, is confirmed in many successive documents.

The "Council Resolution of 24 November 2003 on the deposit of cinematographic works in the European Union[8]" after reaffirming that "European cinematographic works constitute a heritage that has to be conserved and safeguarded for future generations" acknowledges that in order to preserve them, cinematographic works should be "systematically deposited in national, regional or other archives".

---

[7] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2000:193:0001:0002:EN:PDF
[8] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32003G1205(03):EN:NOT

The issue of the complexity and criticality of the preservation of digital media is also subject of several EU official documents. For example, the "Council Resolution of 25 June 2002 on preserving tomorrow's memory — preserving digital content for future generations[9]" notes

> *"that the cultural and intellectual assets of our society, which are created, usable and available in digital form […]are at great risk of being irremediably lost unless positive measures are taken to preserve them and to keep them available for the future"*

and that

> *"memory institutions such as archives, libraries and museums have a central role to play in these (measures)";*

therefore it proposes several objectives, including "stimulating the development of policies for preserving digital culture and heritage, as well as their accessibility.

Similarly, the "Commission Recommendation of 24 August 2006 on the digitisation and online accessibility of cultural material and digital preservation[10]" recommends that Members States

> *- establish national strategies for the long-term preservation of and access to digital material, in full respect of copyright law […]*
> *- make provision in their legislation so as to allow multiple copying and migration of digital cultural material by public institutions for preservation purposes […].*

Needless to say, the cultural as well as economic importance of the preservation and accessibility of European cultural heritage is at the centre of both "A Digital Agenda for Europe[11]" and the "The New Renaissance – Report of the 'Comité des Sages'"[12].

Finally, the "Recommendation of European Parliament and Council Recommendation of 16 November 2005 on film heritage and the competitiveness of related industrial activities"[13] and the most recent "Council Conclusions on European film heritage, including the challenges of the digital era (November 2010)"[14] both reconfirm the need of preserving and making accessible the cinematographic heritage and make a number of key considerations and recommendations, including on digital challenges and opportunities, defining an impressively clear and comprehensive course of actions for EU institutions and Members States. The analysis of these recommendations in light of the most recent developments in this domain is part of the remit of this study.

Another clear indicator that cinema is defined as a key component of all Member States' culture is the fact that the cinema industry (and most notably production) is supported to a significant extent by public funding, in many different forms - direct public funding for production, distribution etc., or tax shelters and other instruments from Members States or the Commission (via the MEDIA programme).

---

[9] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2002:162:0004:0005:EN:PDF
[10] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:236:0028:0030:EN:PDF
[11] http://ec.europa.eu/information_society/digital-agenda/documents/digital-agenda-communication-en.pdf
[12] http://ec.europa.eu/information_society/activities/digital_libraries/doc/reflection_group/final-report-cdS3.pdf
[13] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32005H0865:EN:NOT
[14] http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/educ/117799.pdf

While economic and industrial considerations do play a role, cultural reasons as seen as vastly predominant to justify the public support to cinema, as proven by a survey of film funds across Europe[15].

Although it seems to be difficult to pinpoint exact figures, estimates of the European Audiovisual Observatory[16] place state aid to film industry at around 1.6B€ / year in direct aid to which approximately 1B€ / yr in tax incentives should be added. Along the same lines, according a study[17] analysing the financial structure of European cinema:

> *"the primary source of cinema funding in Europe is public sector support. The reimbursable and non-reimbursable funding of films accounts for a range of 42% on average (Italy, Spain) to 60% in certain cases"*.

Although these figures might have changed or not be 100% accurate, the reality of European cinema as one heavily subsidised remains unchanged. Furthermore, the reasons for these subsidies are largely cultural.

In conclusion, legislation at national, regional and European levels, and a long-standing, significant practice of support to the industry prove the point that

> *"European cinematographic works are an essential manifestation of the richness and diversity of the European cultures and that they constitute a heritage that has to be conserved and safeguarded for future generations"*[18]

The analysis, conclusions and recommendations presented here are driven solely by the intent to advise on the best strategies to achieve the goals defined in the abovementioned documents and legislation, to the best knowledge and experience of the authors, and on the basis of the wealth of information gathered in the process of preparing this study.

Summary

- The Study moves its analysis and its recommendations on the assumption that **cinema is worth preserving for the future, and it is worth being given access to.**
- This is based on a vast body of National laws as well as documents, recommendations and directives at European level
- Another clear indicator that cinema is defined as a key component of all Member States' culture is the fact that cinema industry is supported to a significant extent by public funding.
- State aid to film industry is calculated at 1.6B€ / year in direct aid, plus 1B€ / year in tax incentives. Cinema is an important investment for MS.

---

[15] On a scale with 0 as 'neutral balance', -6 as 'mostly commercial' reasons and +6 as 'mostly cultural reasons', average score is +3.4 with only 2 countries out of 27 choosing 'commercial' and only 5 voting 0 for 'balanced'. "ThinkTank on European Film and Film Policy The Copenhagen Report", 2007. http://www.filmthinktank.org/papers

[16] Figures from the European Audiovisual Observatory.

[17] "Identification and evaluation of financial flows within the European cinema industry by comparison with the American model" study n° DG EAC/34/01 http://ec.europa.eu/avpolicy/docs/library/studies/finalised/film_rating/sum_en.pdf

[18] "Recommendation of the European Parliament and of the Council on film heritage and the competitiveness of related industrial activities", ibid.

1.3 Methodology

The task of assessing the challenges and opportunities for the Film Heritage sector in the Digital Era is undoubtedly a complex one.

First, the complexity and depth of the technical changes in the whole chain of cinema production and distribution, and obviously in archiving and preservation, are impacting archives on a number of levels and in all sectors of their activities. The sector is highly multidisciplinary and collecting, preserving, restoring and distributing film is characterised by extremely interdependent processes.

Secondly, the differing dimensions and variety of the players in this sector, with many public and private bodies and institutions differing in size, funding levels, vocation, and activities adds to this complexity.

Another reason for this complexity is the differences in the Members States' legal frameworks, regulations, structures of the sector, and interaction of the Film Heritage sector with others, such as production and distribution.

The only way to address the challenge of producing a comprehensive, coherent amount of information, a useful analysis of the present situation from which sound and consequent proposals and conclusions are to be derived, is to base the whole process on a solid methodology and a correct understanding of the problems and issues.

The results contained in the study are based on a methodology designed to gather as much input and feedback as possible from as many stakeholders as possible. Therefore the following methodology was followed:

- **Analysis of relevant literature** (based on a 'selected bibliography' consisting of some 200 entries, including literature from most relevant EU projects).

- Receiving input and support from **an Advisory Board**.

- **Distribution of some 150 detailed questionnaires**, aimed at gathering statistical data as well as general information and opinions about the issues discussed in the study and addressed to FHIs, government bodies, experts and the industry.
  In total, the Study received 55 answers to the questionnaire, from Institutions in 17 Member States and of EU-wide associations like ACE, which represent all large European FHIs.

- **In-person interviews** with some 40 experts from 32 bodies, including EU-wide associations from the industry, interviews with FHIs and industry experts in the US; in overall, 30% of the interviewees were from the cinema industry. Most of the interviews involved multiple experts and lasted 2.5 hours on average.

- **A half-day brainstorming session** where the preliminary results were discussed with a selected group of experts.

- **An online-consultation** (open between the 13th of July and the 30th of September, 2011) to gather insight and feedback from the widest possible number of stakeholders (18 responses from bodies and individuals in 7 MS and 6 EU-wide associations were received).

- **A public workshop** to discuss and finalise the results and recommendations, held in Brussels on the 20th of September.
  The workshop saw the participation of 99 people from 17 MS and the US; participants included 30 FHIs, 17 government bodies, and 28 representatives of the cinema industry.

In summary, via surveys and interviews, the study received valuable input from more than 100 institutions, bodies and individuals located in 17 Member States and in the United States; this figure includes many associations representing a vast number of members in all EU MS.

As experts responsible for the study, we want to thank all those who contributed to this study, by accepting to be interviewed, by responding to the questionnaire, or by sending written comments and contributions.

Our special thanks go to the members of the Advisory Board and to the experts who participated in the Brainstorming session:

Ian Christie (Birkbeck College, University of London, UK),
Claudia Dillmann (Deutsches Filminstitut, ACE-Association des Cinémathèques Européennes, Germany, also member of the Advisory Board),
Siegfried Foessel (Fraunhofer Institute, Germany),
Jean-Pierre Gleyzes (CNES-Centre National d'Etudes Spatiales, France, also member of the Advisory Board)
Mikko Kuutti (National Audiovisual Archive, Finland, also member of the Advisory Board),
Jean-Michel Rodes (Institut National de l'Ausiovisuel, France, also member of the Advisory Board),
Béatrice Valbin (StudioCanal, France, also member of the Advisory Board).

2. Drawing the digital landscape for European cinema

2.1 Cinema IS digital

"Cinema is Digital". This is not a possibility or a future development anymore, it is a reality. Although the percentages for the digitisation of European screens vary significantly by country and by type of theatre, it is clear that there is no 'going back', the digitisation of all European cinema distribution is well underway and most experts indicate 2012 as the 'tipping point' when the majority of screens will be digitised.

Over the past two decades, cinema moved progressively to the complete digitisation of its production, post-production and distribution chain.

2.1.1   Acquisition and post-production

Post-production (as image and sound editing and processing, special effects) has been digital for many years now, and nowadays almost all films produced across Europe are being finished using some form of digital workflow.

'Shooting' is also moving fast towards digital acquisition: the vast majority of current films (and TV fiction) are produced with some sort of digital cameras, while the number of productions that are still "shot on film" is decreasing at a very fast pace. As an executive of a major US studio pointed out in the context of this study, "while a couple of years ago the ratio between works shot on film vs. those shot on digital was 80% to 20% in favour of the former, now the ratio is precisely reversed, with the percentage of productions using film constantly decreasing".
Many European countries hardly see any cinema work shot on film, even in France, among the slowest to adopt digital capture in Europe, in the first quarter of 2011 only 36% of productions were using film cameras[19]. Major manufacturers of film cameras (ARRI, Panavision, Aaton) recently discontinued the production of film cameras and focused entirely on digital equipment[20].

The combined effects of the digitisation of acquisition and post-production, the increased computing power of IT hardware at consumer or prosumer level, the marketing strategies of some software manufacturers, led to 'lowering the bar' significantly in terms of investments (and costs) required for the technical component of cinema production (i.e. capture and post-production) thus potentially reducing production costs and opening the market to new, smaller players. For the first time since the teens, it is literally possible to shoot, edit, finish, and produce release digital prints "from the kitchen table". This poses serious and obvious challenges in terms of preserving these productions.

---

[19] Source: Fédération des Industries du Cinéma, de l'Audiovisuel et du Multimédia – www.ficam.fr
[20] http://magazine.creativecow.net/article/film-fading-to-black

2.1.2   Theatrical distribution

Other than for theatrical exhibition, all distribution formats (broadcasting, home-video, etc.) have been digital for a long time.

Theatrical distribution is basically the only component of the cinema chain that still uses analogue film, but this is not to last very long, as the rate at which global and European theatres switch to Digital is constantly accelerating.

Aggregate figures for the European market indicate that 30% of the screens were digitised at the end of 2010, with a pace that is constantly increasing (+20% in the first quarter of 2011 on the previous period[21]). As it is often the case in the European marketplace, the picture is quite differentiated across the Member States.

It is not easy to pinpoint figures of D-Cinema penetration in each European country as this is literally a 'moving target' and the rate of growth is accelerating. By combining figures from the European Audiovisual Observatory, the picture of penetration of Digital screens at the end of 2010 is quite differentiated. At the top we find countries like Norway (100%, the first country to be completely digitised), Belgium (65% of screens are digital), Portugal (55%), Austria (53%); countries like France, the UK and the Netherlands passed the 50% threshold in 2011, while other markets (among them Germany, Italy, Denmark, Ireland) 'score' between 40% and 25%; while the overall percentage in the EU27 is 30%, the percentage in Western Europe is higher than in Central and Eastern Europe (40% against 30%).

It is important to highlight that the pace of conversions is stepping up: as of Dec 31, 2010 34% of screens in France were digital, but it is now past 50%.[22]
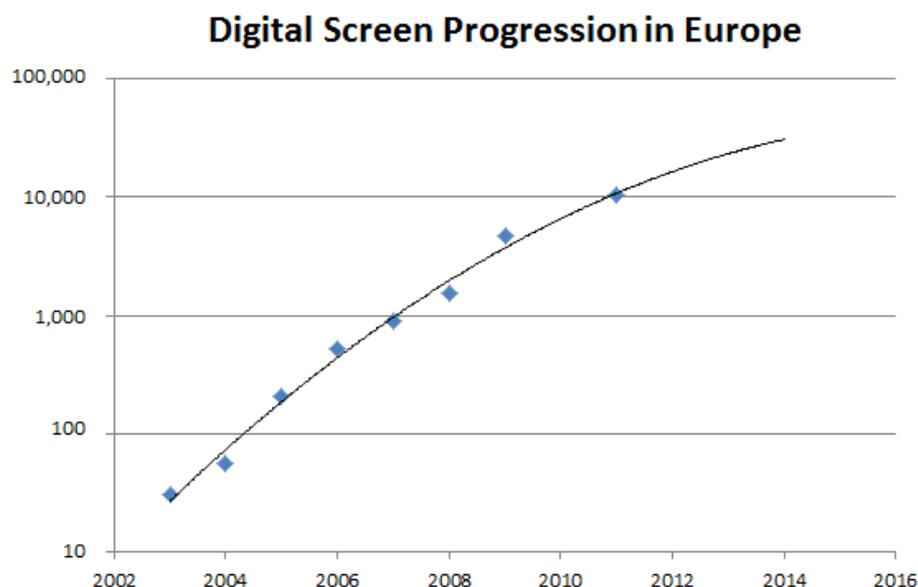
Digital screen progression in Europe. Source data: European Audiovisual Observatory

---

[21] Source : Digital and 3D cinema market trends in Europe Q1 2011, Screen Digest
[22] Source: http://www.cinego.net/basedesalles

Based on similar figures, most analysts place the 'tipping point' (when D-Cinema will become predominant against 35mm projection, thus pushing analogue projection at the fringes of the market) for most key markets in 2011 or 2012[23].

Concerning the number of films that are actually distributed in digital format, again the situation in the European countries is quite different as it obviously follows the digitisation of the screens. As an example, figures of digital releases in the UK show again fast growth and a clear trend towards 100% (which most probably was reached already in 2010 see table below)[24]. On the other hand, in 2009 France saw only 15.3% of digital-also releases (but the percentage reached 30% at the end of 2010[25]).
As a point of reference, the situation in the US is that *all* first-run theatrical releases are distributed in digital format.

It is also important to point out that in Europe, already now, many works are distributed *only* as DCP and this is particularly true for low-budget, independent films that benefit from the lower production costs of digital masters and prints. In many cases, these are also the works that constitute both the major source of cultural diversity and whose preservation is most endangered by the transition to

Digital releases - UK 2004-2009
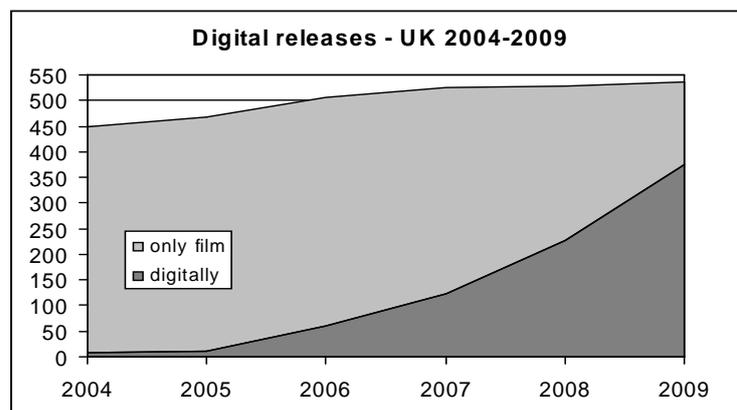
Digital film releases - UK	2004	2005	2006	2007	2008	2009
Number of first-run releases	450	467	505	525	527	535
Digital releases	8	11	59	123	227	375
	2%	2.5%	12%	23%	43%	70%

digital.

Summary

- Cinema IS digital. Now. Over the past two decades cinema moved progressively to the complete digitisation of its production, post-production and distribution chain.
- Other than for theatrical exhibition, all distribution formats (broadcasting, home-video, etc.) have been digital for a long time.
- Most analysts place the 'tipping point' (when D-Cinema will become predominant) for most key markets in 2011 or 2012. Some countries are already almost completely digital.
- Already now, virtually all films are distributed *also* digitally. Some are distributed *only* digitally.

[23] Se...
http:...
ciner...
[24] So... ...on European Film and Film Policy, Background and Position Paper on D-Cinema 2010, http://www.filmthinktank.org/papers
[25] Source: Fédération des Industries du Cinéma, de l'Audiovisuel et du Multimédia – www.ficam.fr

2.2 A double loss?

2.2.1 Analogue fade-out

The trend in digital screen penetration and in digital distribution has a direct impact on the whole industrial infrastructure centred on analogue film. 30% screens being digital means that the need for analogue release prints is down by *at least* 30% (as premier theatres are the first to turn digital, the percentage is higher for blockbusters, which, by the way, are also the titles for which the largest amount of release prints are produced).

Decline in use of analogue film is clearly to be seen in the revenues deriving from sales of film stock (aggregated positives, negatives and laboratory film stock). Official figures from FujiFilm[26] show a strong decline in film material sales in the last years, shown in the table below. As a word of caution, it is important to remember that these figures include the photographic sector, which was impacted earlier and more seriously than cinema by the arrival of digital imaging

YoY % decline in revenues from photographic material

2004	2005	2006	2007	2008	2009	2010	2011
-14%	-23%	-18%	-20%	-27%	-35%	-32%	-20%
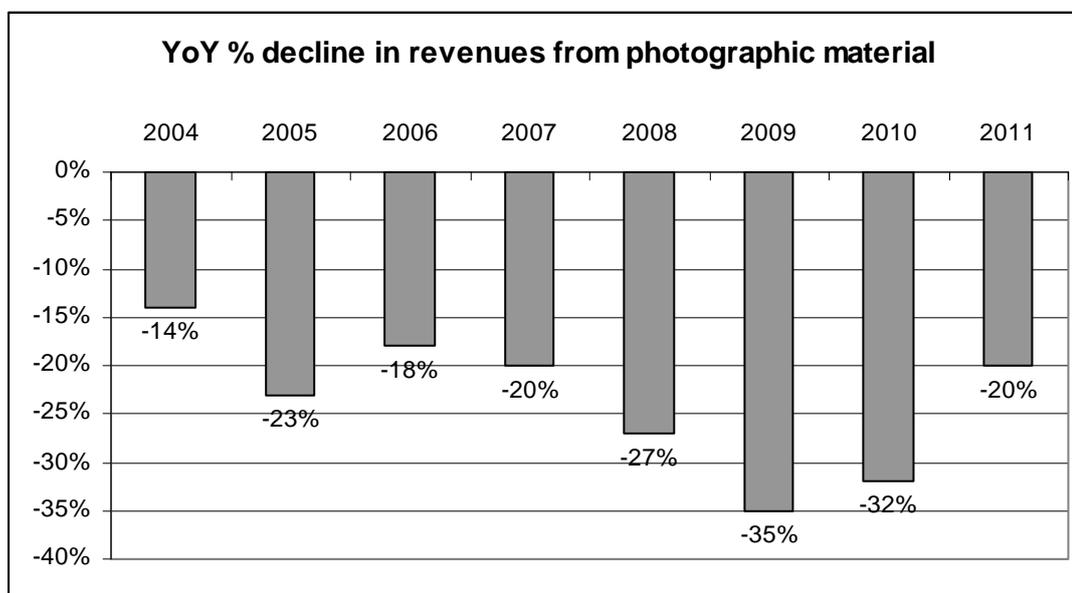
devices.

Always based on official figures, Kodak's Film, Photofinishing & Entertainment Group[27] also show a constant, although less steep, year-on-year decline in revenues:
-14% in 2011 and 2010, -24% in 2009, and -13% in 2007 (the two companies' figures are not directly comparable as they aggregate revenues from different categories of products, due to the different internal organizations of the two companies and their divisions).

Obviously, it might take many years before the last metre of film will be produced and the last film projector will be dismantled, but at this point the question is not "whether or not", but rather "when".

---

[26] http://www.fujifilmholdings.com/en/investors/ir_events/earnings_presentations/index.html
[27] http://investor.kodak.com/phoenix.zhtml?c=115911&p=irol-irhome

The dynamic of such technological transitions as seen in other industries is typical. A slow adoption phase is followed by a rapid increase in the rate, until the dynamic reaches a 'tipping point' and then the transition is completed extremely fast. The 'tipping point' is defined as the point when maintaining a technology on the way to obsolescence becomes too complex and costly and when the majority of products of the industry are destined for the new technology.

This is what is happening to analogue film projection in all those markets that reached the 'tipping point': increased costs of maintenance and complexity in keeping two completely different technologies in operation (doubling the amount of spare parts, service contracts, requiring staff with two different sets of skills, etc.) progressively make the investment in new equipment economically more interesting, particularly when premium content is offered only in digital format (as with 3D).

Such a dynamic has been present in the cinema industry for few years now and is leading to a deep restructuring of the whole post-production industry. Analogue film technology is already extremely complex and costly to maintain in all parts of the production chain: equipment for viewing and inspection, laboratory equipment, even consumables (cans, cores, tape, cement, etc.), they are all becoming 'niche' products produced by one or two vendors worldwide, while technicians and spare parts are rare and costly, as they have to come from abroad (if they exist at all).

The decline in the production of analogue release prints that is directly proportional to the increasing number of digital screens, together with the decline in the use of film negative as capture medium (which is replaced by digital cameras on a growing number of productions - from TV series to commercials and feature films) are also leading to a crisis of the traditional 'analogue film laboratory', and a deep change in the typical 'digital post-house' as film scanning becomes less important in the workflow.

It is worth highlighting that analogue film laboratories that perform preservation work on film for FHIs, have been diminishing in number and in the services they are offering across Europe for few years now. As a result, it is becoming harder for FHIs to find film-to-film preservation services across Europe, to the point where some 15% of the respondents to the study's questionnaire openly ask for public support to maintain film laboratories.

On the other hand, the traditional 'digital film lab' that dominated the industry in the past decade, i.e. large, investment-intensive structures built around one or more high-priced scanners or high-end telecine machines is also in crisis, as the use of digital cameras and the fast declining costs in post-production technology (colour correction, digital editing, special effects, etc.) make their business model and structure less competitive.
As mentioned earlier, the new rising model is a 'light lab', potentially a 'kitchen-sink' operation with a low barrier to entry investment-wise. From the FHIs' point of view this means that costly film-to-digital transfer equipment such as scanners and telecine, already suffering from over-capacity, will be soon phased out from the mainstream cinema post-production market.

2.2.2   Losing the cinema of the past

The combined effects of these trends in the cinema marketplace are likely to have a significant effect on the whole preservation and digitisation environment in the short and medium term.

Despite some archivists' calling over the past few years to "turn the digital tide back" by taking dramatic actions (e.g., buying Kodak's film business, having state aid for film laboratories, and other proposals which were vented), the reality is that the market forces that are at work in this environment are far too strong to be influenced by any improbable concerted effort, even by all the world's FHIs, as their market share is irrelevant in systemic terms and investments in maintaining film stock and film equipment production are fairly significant (the global pre-D-Cinema release prints business alone was commonly calculated at some \$2B[28]).

In other words, any strategic recommendation to help preserving and making cinema accessible for the European citizens must take into account these dynamics and economic realities that are reshaping the environment in which the FHIs operate.

The consequences of these changes and trends in the environment – which, it is worth remembering, are already all well underway – are, and will be, impacting seriously the activities of the FHIs and as this study hopefully demonstrates, require decisions and actions in the short term.

2.2.2.1   No more film projection

Within the next two to three years, **analogue film projection is going to disappear** from all commercial circuits (at least in Europe's largest markets), and it will be limited to few specialised cinemas across Europe, most probably within FHIs. Progressively, the task to maintain film projection operational will become more and more costly and complex. In the long term, it will become ultimately almost impossible to maintain and film projections will become rare and precious events, at best.

Because of their large collections of analogue films, because of the characteristics of certain film works that require a film projection in order to maintain their original visual impact, or simply because it will take years before digitizing all the films that need to be shown is complete, FHIs will continue to use analogue projection, together with digital projection, for as long as it will be technically possible. And it is also possible that few art houses and specialised cinemas across Europe will continue to do the same.

This means that FHIs will have to maintain analogue film projection alive in a world that has gone digital, and this endeavour is going to be time-consuming and very costly as technicians, companies, and spare parts become rare and expensive.

But as FHIs manage very few screens, and these tend inevitably to be located only in capitals (or at least in large cities), this means that while their impact is culturally very important, it cannot change the picture at the systemic level: in a

---

[28] See for ex. ThinkTank on European Film and Film Policy, Background and Position Paper on D-Cinema 2010

couple of years if anybody wants to watch or project a movie, they will have to do so digitally.

Countries where the D-Cinema penetration is higher, like Belgium, are good examples of the consequences. As soon as the percentage of digital screens reaches 50-60%, maintenance and technical services for analogue projectors start dwindling and ultimately disappear.

When most theatres are digital, the collections of analogue film elements are not useful anymore as they cannot be projected. Loans to other institutions collapse and projections for schools drop to zero (except in the local FHIs). Finally, when distribution turns completely and only to digital, collections and deposit risk dropping also to zero, except in formats not suitable for preservation.

2.2.2.2 No more film laboratory services

Photochemical laboratory services are doomed to progressively disappear, and this includes not only the production of release prints, but also any photochemical preservation process that might be required by FHIs. On this subject, it is important to highlight that even when cinema content needs to be digitised, some degree of photochemical processes are required simply *in order to* digitise. Besides, most FHIs consider that basic preservation work is necessary and will be necessary for as long as they are sustainable. For example, copying a nitrate negative onto a modern polyester duplicate positive not only is the safest course of action from a preservation point of view, but might give better results in terms of image quality, and reduce time and costs in the digitisation process.

In the medium term, only FHIs that are already equipped (as it is the case for some European FHIs like London, Brussels, Paris, Berlin, Bologna…) will be able to continue film-to-film preservation work, albeit at increasing costs, and only while film stock remains available and affordable.

In the short term the closure of analogue film laboratories potentially offer the FHIs the opportunity to take advantage of an increased supply of personnel highly qualified in analogue techniques (albeit not necessarily in preservation techniques). But this advantage will soon disappear as most of the senior staff currently employed by analogue laboratories are at the end of their working lives.

In fact, in the medium to long term FHIs will face a serious problem in finding staff with any knowledge and experience in the analogue world of cinema. This trend is already noticeable today when for example students coming from universities or film schools have hardly been exposed to any form of analogue technologies in their lives: no films, but also no discs, no analogue audio tapes, no video cassettes, etc.

2.2.2.3 No more scanning, less restoration R&D

In the short term FHIs will also benefit from an excess in supply of scanning services, as scanners are less and less used for contemporary cinema or TV productions. This will be beneficial to any digitisation project as prices are likely to drop significantly in the next 36 to 48 months.

In the medium term, though, most operations will either shut down, or stop offering scanning services, as these will also become 'niche' markets with limited margins and high maintenance costs, as scanners will not be in use in the high-margin market of commercial productions anymore.

Ultimately, all scanning services will be limited to digitisation projects and then finally they will also fall out of the mainstream of the industry, with the consequences of becoming a high-cost niche market with little R&D, inevitably resulting in dwindling quality and reliability.

Competences and skills in anything related to film technology (which was already reduced by the closure of film laboratories) will also disappear from digital post houses, as they will not touch film anymore.
In the medium term (i.e. 5 to 15 years when the last generation of film technologists retires) film will be officially an obsolete and largely forgotten technology.

There will be fewer and fewer colourists used to work with film-originated images, and fewer operators with knowledge of analogue imaging.

Historically, the industry for digital image restoration software has until now been supported by current productions, usually via insurance. Modern camera negatives are in fact also subject to be damaged (e.g. scratched during shooting), and for many years insurance companies have been among the most important customers for restoration services, requiring costly repairs in order to avoid the even higher costs of reshooting whole scenes.
When capture will be 100% digital, any development in the field of restoration software and techniques will be only driven by digitisation projects; it is therefore expected that investments in R&D will decrease exponentially. Like scanning, digital image restoration will become an activity strictly limited to the relatively small market of digitisation projects.

2.2.2.4   The window is closing

The combined results of these phenomena is that not only is digitisation advisable and necessary in order to make the works of the past accessible in an environment in which film projection is disappearing fast and will be soon limited to the specialised cinemas belonging to FHIs, but that **the window of time when digitisation is possible at reasonable costs and with realistic expectations of obtaining reasonable quality**, **has already started closing**.

In conclusion, digitisation is not only necessary, but urgent for reasons that are basically out of the control of FHIs.

If actions are not taken within a 'window of opportunity for digitisation' that this study foresees to be of 7 to 10 years, the most likely scenario is of a dramatic dual loss, as described below.

Summary

- Analogue film technology is declining fast, in laboratories services, in film stock sales and in projection technology
- The whole industry centred on analogue film is slowly fading away
- Within the next two/three years, **analogue film projection is going to disappear** from all commercial circuits and will be limited to few specialized cinemas across Europe.
- Analogue film laboratory services used by FHIs are already disappearing

© E

2.2.3   Losing the cinema of the future – the 'default' scenario

The following scenario is based on the assumption that pure market forces drive the evolution of the technical ecosystem surrounding the cinema industry, and projects the direct consequences of this evolution onto the future of cinema preservation in Europe.

For many decades now, FHIs around the world have been playing an objective role of support to the film industry by bearing the costs of storing, conserving and preserving film works; this was particularly true when catalogue titles were not producing any revenues – in other words, before the advent of cable TV first, and DVD and Blu-Ray later.
In Europe, this role of support has been played by numerous FHIs, some of them (the national archives) are officially and legally entrusted with the preservation and conservation of the national cinema production (this is not the case in the US, though). FHIs both in the US and Europe have been restoring and preserving cinema works basically from the very beginning of their history.

With cable TV and home-video, cinema catalogues turned into 'assets' as they acquired an economic value. This led to a renewed cultural and commercial interest in film restoration that continues to today. In most cases and in most countries this then led to a closer collaboration between FHIs and rights-holders.

In very broad terms, and with an inevitable degree of simplification, this collaboration took two very distinct forms in the US and in Europe.

In the US behind early 'pioneers' like Sony and Warner, all major studios and some of the smaller producers have developed an important activity of preservation and restoration of their catalogues, alone or in collaboration with FHIs. Funding for this activity comes largely from the studios, with a significant contribution from private donors and foundations (this being the normal way of funding FHIs in the US where public funding is virtually non-existent). In other words, in the US it is true that the industry is funding the digitisation and the restoration of a very large number of works per year, with FHIs increasingly focusing on works that lack support (independent, avant-garde, documentaries, etc.).

In Europe on the other hand, virtually all restoration activities have been financed by public funding usually via FHIs[29]. The last few years saw some (limited) funding coming from donors and sponsors, and some activity in the field of digitisation and re-mastering, largely due to the demand of TV channels for new High Definition masters.

If anything, the recent initiative of the French government[30] to fund the digitisation of French classics show that even in the context of one of the strongest cinema

---

[29] With the exception of documentaries and newsreels that were often digitised by the owners because they were seen as more likely to produce revenues as stock footage. But feature films were always considered not worth restoring, at least until the beginning of this century.
[30] See http://www.cnc.fr/web/fr/actualites/-/liste/18/135306

industries in Europe, the European private sector is not able to fund the digitisation of its catalogue.

The reasons behind this reality are the same that concur in making the European cinema industry less competitive than others, the fragmentation of the market, the relatively low appeal for European works outside the (often relatively small) domestic market, and last but not least, the fragmentation of the industrial structure, with a very high number of companies producing few films per year[31]. The downward trend in post-production costs and the increased access to the market offered by D-Cinema clearly will not help the consolidation of this market, but rather lead to its further fragmentation.

For all these reasons, this study considers it extremely improbable (to say the least) that the European film industry as such (i.e. as a whole, while of course individual exceptions are always possible) can and will bear the costs or undertake the necessary organisational changes required to preserve new digital works, and to digitise the significant number of works produced in the past.

As a consequence, this means that unless actions are taken by the public sector to support FHIs in their activities of digitisation and digital preservation, the 'default scenario' facing European cinema, meaning the scenario that is doomed to happen if no actions are taken, is definitely that of **a double loss**:

➤ In the very short term (literally months in some MS, and perhaps two years in the others) film distribution will make a massive migration towards digital projection. The demand for 35mm projection copies will be dramatically reduced. At the same time, film capture will move to digital, causing the same dramatic decrease in the demand for 35mm film negatives and laboratory work. As a consequence the supply of film stock will fall either to zero or to very small volumes, driving a strong increase in prices if/when quality has still to be maintained, which in turn accelerates **the reduction of 35mm based activities to a very small niche of high-price**, **low-volume speciality products and services**.

➤ Production masters of new "born-digital" films are not transferred onto 35mm elements because of lack of on-film distribution. Digital masters stored by the producer at the producer's premises are generally stored on a hard disc drive or LTO tapes[32], with neither infrastructure nor processes in place to secure long-term preservation of digital works. **5 to 10 years after the end of the initial commercial exploitation phase**, **most of the data stored on these drives and tapes will be definitively lost**.

➤ Working copies of these digital masters will be kept by technical laboratories subcontracted by the producers, as is current practice in some facilities already handling significant volumes of digital material[33]. These laboratories,

---

[31] This is a well known factor, but an interesting example can be taken out of the analysis carried out by the "ThinkTank on European Film and Film Policy" on the 344 European films that were in the official selection of Berlin, Cannes and Venice, 2002 – 2005 and Toronto, 2004 and 2005. Among other interesting statistics, the ThinkTank's analysis shows how these 344 films were produced by 40 producers, that 17 of them had produced more than 16 films in those four years (2002-2005), but that none of them had produced more than 10 films in every one of the those four years.

[32] Linear Tape-Open, the dominant data tape format http://www.lto.org/

[33] Information on working practices gathered during interviews with different organisations in the course of gathering information for the project.

however, are unlikely to be the traditional laboratories with the associated benefits of a long history of analogue film processing and archival. Most of them will be new digital labs centred on digital post-production, and will be based heavily on dynamically changing IT infrastructures and workflows. Increasing competition in this area will drive further price reductions, and **make it uneconomical and almost impossible for digital labs to reliably and securely preserve over the long term huge amounts of digital data** (2 to 8 Terabytes per digital master) **unless this becomes a paid service.**

➢ Charging producers the actual cost of active data preservation, including format and technology migrations every 5 years or so, will not be possible as most producers will generally not be able to pay the price required to maintain the data alive. This will force the labs, after a period of time, to either delete data or decide not to include them in the next migration. **In most of the cases digital master data kept on the labs' premises will be lost some 10 years after the end of the active exploitation phase.** Those masters delivered and stored using encrypted formats, driven by fears of "digital piracy", will be subject to even greater threats and risk, as the same uncertainties will govern the fate of all actors involved in the encryption / decryption chain. **It is highly likely that any data stored in encrypted form**, **where the producers have kept full control of the key systems**, **will be lost within 10 years.**

➢ It is likely that some producers will be satisfied with maintaining only lower resolution "masters" that are dedicated to existing distribution channels such as DVD and Blu-Ray, as there is an immediate commercial return for these lower resolution versions[34], and the size and storage costs are much lower than those of full-resolution digital masters. But **home-video standards and customers' requirements change every 10 years or so, making lower resolution versions eventually irrelevant for both cultural and economic purposes.**

➢ **All films produced before the full transition to digital will not be accessible in their original film format as theatres will accept digital material only**. **Digital copies will have to be created, representing a cost that will grow rapidly over time as analogue film equipment and expertise diminishes and eventually ceases to exist**. Such digital copies will face the same threats and fate as described above for "born-digital" works, this being aggravated by the perception that such digital copies are of even lower value than film originals.

➢ In this "default scenario", which is unfortunately almost certain if no radical initiatives are launched to counter fundamental trends at play in digital technology and market evolution, Europe will face two dramatic losses impacting its culture, identity, history and its economy:

➢ **most "born-digital" works will be lost as they will cease to exist 10 years after production, and**

---

[34] For example, the "Projet de dispositif du CNC – Numérisation d'œuvres cinématographiques patrimoniales" foresees the return to film after digitisation having a resolution of 2K (format IMF 2K). See http://www.cnc.fr/web/fr/actualites-/liste/18/135306 "le projet de dispositif du CNC".

> ➢ **most works produced in the 120 years preceding the present "digital revolution" will be lost as they will no longer be accessible any more to the wider public**.

Summary

- It is extremely improbable that the European film industry can and will bear the costs or undertake the necessary organisational changes necessary to preserve new Digital works, and to digitize a significant number of works produced in the past, without public support.
- If no actions are taken, Europe faces a **double loss:**
- 5 to 10 years after the end of the initial commercial exploitation phase, most of the digital films will be definitively lost.
- **most "born-digital" works will be lost as they will cease to exist 10 years after production, and**
- **most works produced in the 120 years preceding the present "digital revolution" will be lost as they will no longer be accessible any more to the wider public.**

2.3 D-Cinema and other access models

The technology of cinema productions (from 'shooting' to the completion of a 'master') is a relatively small market for highly specialised equipment that is sold in small numbers. Within this fairly small market, cinema archiving (from scanning to restoration) is really a niche market, and as such it cannot influence the overall cinema technology and standards, at least not without support and intervention.

The only sections of the cinema chain that are not 'small' in market size are distribution and exhibition, two areas where any important change in technology and standards entails significant investments.

For this reason, the only point in the cinema production chain where the process is heavily standardised is at the end, right at the point in which a work is distributed. None of the technologies used 'behind the scenes', i.e. on the set and in the editing room need to be standardised. On the contrary, they should be free to evolve constantly towards better quality and lower costs.

All entities concerned with the preservation of cinema materials know this very well. They acknowledge that the only point where standardisation can be expected and should be required is for the finished work at the point of distribution.

2.3.1 D-Cinema standards

In the case of digital distribution of cinema today, standards are being finalised at SMPTE[35] and ISO[36].

The key components of D-Cinema standards have already been largely approved, and in broad terms the picture is clear. As was mentioned earlier, cinema works are produced with a wide range of technologies and workflows that are almost entirely digital from capture to completion of a master. In other words no matter whether the capture technology is a film or a digital camera, the final result at the end of the chain is a digital master and a film version is produced only if it is required for distribution. And as we saw, this is changing fast with Digital being expected to take over film projection in the short term.

D-Cinema standards clearly define only the very last steps of the chain: the 'digital prints', called *Digital Cinema Package* (DCP) and the master format from which these are produced, the *Digital Cinema Distribution Master* (DCDM).

The DCDM is uncompressed and unencrypted, hence it has a significant size: approximately 1TB per hour for a 2k image format, and four times as much for a 4K (obviously 3D files are twice as large). The DCDM is used to produce a DCP, and it is originated from a digital master of the work, the so-called *Digital Source Master* (DSM).

---

[35] Society of Motion Picture and Television Engineers, http://www.smpte.org/
[36] ISO-International Organisation for Standardization, http://www.iso.org/iso/home.htm

The DSM is not defined in the standards, and in reality it can differ significantly (a DSM can be almost any digital format, although commonly it consists in some sort of HD video format on tape or file, or an image file format - usually DPX, Digital Picture eXchange[37]). For this reason, a DSM is usually not considered an exact representation of the final form the cinema work has, as some significant modifications can take place in the process of the production of the DCDM.

A DCP is really a 'package' containing various files including image and sound components of the work (the so-called 'essence'). In the DCP images are compressed (as JPEG 2000) while sound is not. Being compressed, the size of a DCP is significantly smaller than a DCDM, with a feature film 'weighing' up to around 200GB.

For security reasons, DCPs can be encrypted (although this is not mandatory in the standards and unencrypted DCPs are commonly used, for example for commercials). In this case after encoding the DCP is encrypted using an AES 128-bit key[38]. When the DCP is sent to a theatre, the key to 'open' the DCP is also sent, but it is encrypted using another key that is unique to the theatre's server, so that it can be retrieved only on that specific server. The encrypted key is called a KDM (Key Delivery Message), and it usually contains restrictions for the use of the DCP, e.g. only on a certain day and time, only in one specific language etc.[39]

In other words, an encrypted DCP cannot be decrypted without its KDM, and the KDM only applies to a specific combination of server and DCP and only within a specific time span. This also means that an institution responsible for the preservation of an encrypted DCP cannot perform on that DCP any of the operations that would ensure the long-term preservation of the file.

2.3.2   Digital and analogue 'prints'

Using an analogy with the analogue domain, the DCDM is sometimes said to correspond to a 'negative', and a DCP to be similar to a 'release print'. Despite being quite a simplification, the analogy holds true at a fairly high level and in terms of workflow, but definitely it cannot be simplistically applied from a preservation standpoint as the nature itself of a digital file is quite different from an analogue object.

In fact, decrease in quality (as loss of information and increase in 'noise') is an inherent characteristic of all analogue duplication processes, and it is the primary reason why the quality of a 'master' (e.g. a film negative, or a master analogue tape, etc.) is always higher than the copies it produces. This is the reason why correct preservation policies of all FHIs (and all other archives, libraries and museums) are based on collecting and preserving 'masters'. This is also true for cinema where release positive prints are not considered sufficient as preservation elements: only so-called 'printing elements' are (as original negatives, inter-negatives, etc.).

---

[37] SMPTE standard number 268M-2003

[38] Advanced Encryption Standard (FIPS 197), http://csrc.nist.gov/publications/fips/fips197/fips-197.pdf

[39] The D-Cinema chain is described in many publications, it might be useful quote one article with a preservation angle: "Digital Cinema Technologies From the Archive's Perspective" by Arne Nowak, in the AmiaTech Review http://www.amiaconference.com/techrev/V10_02/nowak.htm

On the contrary, in the digital domain it is possible to produce a copy of a file without any loss of information (although it is wise to point out that this is not always guaranteed and care must be paid to obtain this result). In this sense, the analogy between a DCP and a release print does not hold true as a DCP can be acquired and copied without any loss. Besides, some archivists argue that a DCP is in fact the most faithful representation of the work when it was shown to the public, although an uncompressed DCDM provides the FHIs with more options concerning its future use. This is the reason why Recommendations from the Technical Commission of the International Federation of Film Archives (FIAF) allows both DCDM and DCP as *"acceptable formats for the long-term preservation of cinema work"*[40]

From a preservation standpoint, encryption of the DCP is a most critical issue, as encryption is at odds with long-term preservation, as the FIAF Technical Commission also points out that *"the preservation of an encrypted DCP is at best a risky strategy: occurrences such as the loss of the key, changes in server hardware, failure to decrypt while the KDM is still active, are all likely to render the DCP worthless."*[41]
Hence the recommendation that FHIs should only accept unencrypted DCPs in deposit.

According to the standards, it is also possible to deliver an encrypted DCP (thus protecting it during transport) together with a key that allows the FHIs not only to view the content, but also to decrypt the DCP and eventually re-encrypt it with a new key that this time is in the possession of the FHIs. The procedure is also described in FIAF TC's Recommendations[42]:

> *It is also possible for the distributor to create a special kind of KDM which allows full access to the DCP content. These KDMs are only issued to servers which have been certified as a "Trusted Device", in other words, one which the distributor has certified as being in a secure environment. A certified server using this type of KDM can, within the time frame specified, extract the AES key (in effect the master key) for the DCP, which can then be used at any time to decrypt the DCP and convert it, if wished into an unencrypted form.*

2.3.3   D-Cinema, a stable standard?

In a well-known contradiction, while standards need to be fairly stable in order to protect investors and consumers, they are also based on current technologies and these have a tendency to change relatively often, particularly in the digital world. Nevertheless, standards the change of which would entail massive investments have a tendency to last much longer than others. For that reason, basic features of cinema film technology remained unchanged for many decades, particularly those pertaining theatrical projection.

In the case of digital cinema, the questions of the stability of the current standards and the future of the technology are key to the strategies for the preservation of cinema works that are produced digitally or that are currently being digitised.

---

[40] FIAF Technical Recommendation on the deposit and acquisition of D-cinema elements for long-term preservation and access" http://www.fiafnet.org/pdf/D-Cinema%20deposit%20specifications.pdf
[41] "FIAF Technical Recommendation"
[42] Ibid.

Due to the significant investments involved in the deployment of D-Cinema across the world, D-Cinema standards are expected to be fairly stable, at least in their basic components, and not to change in the years to come. As a matter of fact this assumption is one of the main drivers of the conversion of theatres.

Still, if we look at this from an archival perspective, two considerations must be made.

First, while basic components of the standards remain stable (e.g. the JPEG2000 encoding, or the allowed resolutions, etc.), many 'details' are being further defined or modified; these are considered "minor" in the sense that a simple software upgrade in the servers can avoid interoperability problems and allow the next movie to screen correctly. But from an archival standpoint, this means also that a DCP produced before a given change in the standards might not play correctly anymore. While this is not a concern for exhibitors who tend to be understandably focused on the *next* movie, this can pose problems for the producer, the distributor or the archive who wants to preserve the work and/or make it available in the future.

Secondly, it is both possible and probable that within the next 10-15 years something will change in the standards.
With computing power constantly improving and storage constantly decreasing in cost and complexity, it is not hard to imagine that sooner rather than later we might see D-Cinema going beyond its current specifications. Higher resolutions like 8K keep being demonstrated, higher bit-depths are an option, as more extensive use of higher frame rates (frame rates other than 24 and 48, from silent frame rates up to 60fps, are already in the standards, and they might be used some day). We also should mention new displays (as laser projectors or very large screens vs. projected images, all solutions currently being proposed), or improvements in the sound (e.g., wavefield synthesis).

Similar developments are likely to impact the current standards in the future. Probably this will not happen for a few years and it is highly possible that a dramatically new standard will not *replace* the current one but go alongside it and be even 'backward compatible' to minimise the impact. Still, from an 'archival perspective' that thinks in terms of decades and not in months or years, there is little doubt that FHIs must adopt preservation strategies to deal with standards that are definitely bound to be modified and not to remain basically unchanged as analogue film has been for several decades.

2.3.4   Cinema and digital access

Cinema has been experimenting and adopting new distribution and access models for many decades now, starting with broadcasting films on TV and later with the birth of home video in the late '70s.
Since then distribution and access channels have multiplied, particularly with the advent of digital carriers like DVD and of on-line distribution.

Independently of the medium and channels used, cinema remains in high demand among viewers. On European TV channels, cinema amounts to 35% of all fiction content[43]; VoD channels are largely based on 'archival' content and within this,

---

[43] Figures from the European Audiovisual Observatory.

cinema films takes 62% of all viewing time spent on pure VoD channels (as opposed to broadcasters' VoD channels where usually news play a predominant role)[44]. Although still small in terms of share of revenues, VoD channels are growing faster than other sectors and they are multiplying in number and widening their offer; besides, their business model seems to be better apt to serve a demand-driven market like the one for archival content, characterised by a low number of transactions per a high number of titles.

Figures from the home video distribution (rental and sales) show that access to cinema content is still high in demand. Although no precise statistics are available concerning the market share of heritage content in the home entertainment market, some figures are interesting indicators.

For example, in the UK home entertainment market in 2010[45], videos have a share of 40% (followed by games at 37% and music at 23%); within home-video, cinema content represents 65% of the sales; more interestingly, within the home-video market, 'catalogue titles' represents 72% of units sold (but only 60% in terms of revenues, due to the per-unit price differential, evidently), although the definition of 'catalogue titles' is quite broad (typically 'three months or older') the figures are not without interest.

Moving image content is obviously dominating also the Internet. According to recent figures[46], Internet video (not counting P2P) is now 40 percent of consumer Internet traffic and will reach 62 percent by the end of 2015. The sum of all forms of video (TV, VoD, Internet, and P2P) will be approximately 90 percent of global consumer traffic by 2015. In 2010 consumer Internet video traffic amounted to 4,673 PB/month for over 100 million users in Western Europe. Although cinema content cannot be singled out as such in these figures, 63% of video traffic is produced by 'long form video' which is the typical category for cinema and TV series (as opposed to 'short form video' that is the place for short clips, typical for example of YouTube consumption).

A quick look at statistics for an extraordinary web archive such as "The Internet Archive[47]", where users can freely browse, stream and/or download content that is either public domain or made available via a Creative Commons license, confirms the size of users' demand for archival cinema items. The Internet Archive has huge collections of some 150 billion web pages (!), 900,000 audio recordings, almost three million books and more than half a million moving image items.

In the 'moving images' list of 'most downloaded', cinema content is second only to games with an interesting mix of fiction and documentaries. Some examples include[48]:

- 765,503 downloads for *Night of the Living Dead* (1968), the first 'zombie classic'

---

[44] "Study on the application of measures concerning the promotion of the distribution and production of European works in audiovisual media services (i.e. including television programmes and non-linear services)" Final Study Report, 2009.

[45] Data from ERA Yearbook http://www.eraltd.org/content/stats.asp (accessed June 2011)

[46] "Cisco Visual Networking Index: Forecast and Methodology, 2010–2015" (June 2011) http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360_ns827_Networking_Solutions_White_Paper.html

[47] http://www.archive.org/

[48] Statistics gathered from the Internet Archive website, on June 10, 2011

- 516,196 for *Duck and Cover*, a 1952 cartoon teaching kids how to protect themselves from a nuclear attack.
- 363,556 for a montage of US Department of Defense footage on Nazi concentration camps
- 279,487 - *The Fighting Lady*, a 1944 war documentary by William Wyler
- Various Charlie Chaplin's shorts from the late 1910s regularly score between 250,000 and 280,000 downloads
- 265,636 for D.W. Griffith's 1930 *Abraham Lincoln* biography

In conclusion, cinema content is still at the centre of a wide range of distribution and access channels: linear TV, home-video, IPTV, VoD, web-based services, video to mobile devices, etc. Although demand for cinema content is primarily focused on new releases, archival materials seem to continue being in demand with a strong presence in certain offers that are predominantly based on archive content, such as VoD and other web-based services.

Summary

- Acceptable formats for long term digital preservation of D-Cinema works are the DCDM (D-Cinema Distribution Master) and/or an unencrypted DCP (Digital Cinema Package)
- D-Cinema standard is almost fully defined, but it is not realistic to expect that they won't change in next 10-15 years; FHIs must prepare for that
- In conclusion, cinema content is still at the centre of a wide range of distribution and access channels.
- Although demand for cinema content is primarily focused on new releases, archival materials seem to continue being in demand with a strong presence in certain segments.

2.3.5 Digitisation

All these access channels utilise a wide range of formats that are constantly evolving, in other words access formats must be constantly 'refreshed', thus making it necessary to routinely re-encode the content in a new format. Most importantly, the trend is also towards a progressively higher 'quality of experience' for the users, with parameters such as bit-rate and resolution increasing fast.

Therefore, the selection of quality requirements for digitisation and of target formats becomes critical. Clearly, they are deeply impacted by economic and technical considerations.

The issue of quality is of course a critical one when it comes to digitisation. As digitisation is costly and time-consuming, it is a reasonable goal not to re-do it every time there is an increase in quality. For example, HD TV, Blu-Ray as well as the increased bit-rate for web streaming are forcing the re-digitisation of content that was done in standard resolution (for DVD, for example). This

mistake should not be repeated – or at least minimised in the future. For example, one could argue whether 4k[49] should be considered a target quality, as this format is advancing in the cinemas, and it is even discussed for TV[50].

As a consequence, it is commonly accepted that digitisation should aim at producing a 'master version' the quality of which is as high as the highest possible quality demanded by the potential uses for the content. From this 'master' all delivery formats can then be derived. Hence, life expectancy (LE) of the format, robustness, costs of storage and migration as well as the ease of derivation of other formats from it are all considerations that come into play. Quality of digitisation is of course more than resolution, and is influenced by many parameters as the quality of the materials to be digitised, the equipment used for digitisation, the amount of image and sound restoration and correction introduced, etc.

The analysis carried out by the study of digitisation projects of film material that are either undergoing or planned to start within the next 12 months shows a clear trend toward 2k as the minimum planned resolution, with some projects aiming at 4k, mostly in the case of original 35mm film negatives. Target formats for preservation that are considered or used are DPX, JPEG2000, while 'distribution versions' vary significantly, also over time to the extent that is pointless to discuss them.

This trend is definitely confirmed by benchmarking with the more advanced US market, where the share of 4k (and even 8k for 'premium' restoration titles) is higher, with 2k still being largely used. There the choice of a preservation format is still largely open, waiting for the results of the standardization process of IMF - Interoperable Mastering Format[51], based on JPEG 2000 (with an approach not too different from the one proposed by the EU project EDCINE[52]) or the development of OpenEXR[53], a format that offers more flexibility than DPX, but that would be limited to long-term preservation, with IMF being used as the mezzanine format from which all delivery formats (for TV, home-video, the web, etc.) would be derived.

As image and sound repair and restoration are labour intensive processes, most mass digitisation projects opt against any heavy processing right at the digitisation stage, as these can be performed 'on demand' when the material is actually used, e.g. for broadcasting, home video distribution, or re-use in a commercial production.

However, 'restoration' projects that target one film or a relative small group of films (as opposed to mass digitisations) always use digital restoration, and the amount of processing is increasing as quality expectations increase. As an executive from a digital restoration laboratory stated during the interview: "In the beginning I used to

---

[49] 4k is short for 'resolution of 4096 horizontal pixels', against 2k - 2048 horizontal lines, 1920 for HDTV, or 720 for SDTV.

[50] See for example the recent debate at EBU- European Broadcasting Union:
http://www.ebu.ch/en/union/news/2011/tcm_6-72027.php

[51] See for ex. http://www.imfforum.com/IMF_Forum/Home.html

[52] http://www.edcine.org/intro

[53] http://www.openexr.com/TechnicalIntroduction.pdf See also the Image Interchange Framework (IIF) project at the AMPAS Science and Technology Council http://www.oscars.org/science-technology/council/projects/iif.html

offer three quality levels of restoration, with increasing costs, but now we only offer the top one, as nobody asked for the others".

2.3.6 Workflows

Digital post-production and digital distribution being still somehow 'moving targets' that constantly change depending on the available technology and on the formats required by the many distribution/access models and channels, FHIs and the cinema industry are constantly testing and experimenting with workflows for the digitisation of analogue collections and for the production of new works.

On the side of current productions, as we mentioned earlier, postproduction has been digital for few years now, while capture is still partially on film (although this is decreasing very fast). In both cases, the material 'shot on set' is usually dramatically different from the images of the final work, as special effects will be added, and heavy image manipulations applied during the colour correction / editing phase. From a preservation point of view, this means that they cannot be considered a close representation of the finished work.

At the end of the process a significant number of deliverables are produced for each title[54], these deliverables are used for different purposes (master for TV, for DVD, for Blu-Ray, for D-Cinema, each can have its own colour correction, a different aspect ratio, etc.). Plus each of these can come in different versions (domestic, international, for one specific market or another, etc.), differing in dialogue, dubbing, and perhaps in editing and content.
These deliverables include both data files and digital video.

High-budget productions and large producers define very precise and strict specifications for these deliverables, in terms of both technical characteristics and metadata. These specs usually change from one company to another and are often modified to adapt to the market and the technologies available. On the other hand, small, low-budget productions often cannot afford that level of consistency and they often rely on what each individual post-house will advise them to produce.

Thus, the deliverables can differ from one post-house to another, let alone from one EU country to another! And even more importantly, the description of what each deliverable is changes dramatically, as metadata is usually extremely scarce when it comes to the final delivery formats.

As a result, whenever such deliverables arrive in FHIs, the differing characteristics, and the scarcity of metadata make their correct identification an extremely complex task, while the significant differences in their technical characteristics can pose serious problems in terms of a correct long-term preservation. As will be discussed later, there is a general consensus that this is an area where further standardisation is needed. In the case of D-Cinema content, the above mentioned FIAF Technical Commission's Recommendation aims at narrowing down the range of possibilities by requesting a deposit in two fairly standardised formats, DCDM and DCP, but many FHIs also accept DSM, which, not being standardised, can be dramatically different one from another.

---

[54] In the case of some productions, the list of deliverables can be as long as twenty or more separate formats or versions; potentially they might all end up in one archive one day.

Somehow similar considerations apply to the digitisation / restoration chain applied by FHIs.

Obviously in this case the starting point is always an analogue film that undergoes a scanning process and then it may or may not be subjected to more or less aggressive and long processes of image and sound restoration, editing, colour correction, etc.

'Restoration' is a loose term that not even the archival community managed to properly define and which can be used with many different meanings, some of which are dramatically different, ranging from a simple 'clean-up' for re-distribution to a complex editorial work aimed at reconstructing an otherwise incomplete work. In the past few years, with the increasing use of digital techniques, 'restoration' is mostly employed to mean "image and sound repairs by using digital software tools", and this meaning will be used in this document.

As it has been said, there are almost endless digitisation workflows depending on factors such as: budgetary or time constraints, the approach of the FHIs driving the process, the conditions of the original elements, the final purpose, the equipment available in the FHIs or at the post-house of choice, etc. to the extent that the term 'digitisation' ends up almost losing any concrete meaning. By 'digitisation' some organisations might mean the creation of a DVD off an old VHS or a cheap telecine transfer made in the 80s of a film that is still in the collections. Others refer to a new 8k scan off a camera negative leading to multi-hundred-thousand euro restoration project.

For the sake of understanding, in the context of this study 'digitisation' will be used to define a process of producing digital formats from an original film material at a quality at least sufficient for home-video distribution (Blu-Ray) or theatrical distribution (a 2k DCP).

When it comes to 'restoration', as a 'rule of thumb' we can say that it is never applied (or applied to a very small extent) to large mass digitisation projects, i.e. projects having as a goal the transfer of large quantities of materials on digital formats, usually for access purposes (publication on a website, viewing on site, DVD publications).

On the other hand restoration is always used when it comes to projects aiming at creating a new 'master' or 'restored master' of one specific work.

When it comes to the final deliverables, considerations similar to the ones that we mentioned regarding the industry could be applied to this field: FHIs require, and/or are given a wide variety of formats, changing with time.

Nowadays, according to many post-houses, these deliverables rarely include a 'film-out' (a recording of the digital file onto film). A film-out is required almost exclusively by public archives and only for major restoration projects with major budgets, with the commercial clients almost always being happy with digital deliverables, which over the past couple of years started to include a DCP, even when theatrical distribution is not planned, 'just in case'[55].

---

[55] As a studio executive responded in one interview: "We asked for a DCP, just in case, as we might want to screen it in a theatre one day, and the cost is not significant".

As a conclusion, we can state that the number of possible scenarios resulting in as many workflows, and the speed at which the technology and the market evolve make it impossible to attempt any effort of 'standardising' workflows and procedures. Thus, this makes it extremely difficult to arrive at a precise assessment of costs for restoration. Just to give an example, according to a senior executive in a post-house specialised in restoration, a "restoration project's budget do vary significantly, from a simple HD master for broadcast costing some few thousand euro, to a complete restoration with a budget of several hundreds of thousand, depending on the title and on the partners involved."

The differential in costs is due more to manpower used for semi-automatic and/or manual image and sound processing, and not to the equipment used or the workflow, and the amount of manpower is driven almost invariably by the level of budget available.

For this reason, this study will only discuss costs of digitisation, while no attempt will be made to come to any sort of 'average cost of restoration' because it simply does not exist.

Summary

- Digitisation should aim at producing a 'master version' whose quality is as high as the highest possible quality demanded by the potential uses for the content
- Currently, many different workflows and formats are used for production, distribution and consequently, digitization
- Number of possible scenarios resulting in as many workflows, and the speed at which the technology and the market evolve make it impossible to attempt any effort of 'standardising' workflows and procedures.
- No attempt will be made to define costs for restoration as they differ too much.

2.4 Evaluating the costs

2.4.1 Costs modelling

By far the most challenging question that this study was asked to answer concerns the evaluation of the costs of digitisation and long-term digital preservation.

Answering these questions is extremely complex for a number of reasons:

- The experiences in mass digitisation projects of large film collections are few, definitely not enough to make up the necessary body of data that would be necessary to define costs with precision.
- Precise and detailed information on financial issues are not easily accessible, if at all. When they are shared, this happens under terms of confidentiality; this was the case for basically all the hard figures that the authors of this study were able to gather, either regarding projects, or equipment.
- Budgets from different projects are extremely difficult to compare because they inevitably include different cost components (or none at all). For

example, they might or might not include staffing or facilities costs (usually because in many FHIs these are calculated under a different budget, or they might be easily separated by the overall costs).

- All projects are by far too recent to extrapolate ongoing operational costs.
- From interviews and surveys, all projects run perfectly, with no problems, so the costs of errors, mistakes which are normal in all projects, cannot be factored in, as they apparently do not exist (!)
- Equipment costs are evolving rapidly, both in the general IT domain, and in the specific sector of cinema equipment.
- Creating a model to project costs across 27 MS is extremely complex, as a significant percentage of the costs is (highly specialised) manpower, costs of which are quite different in London, Sofia or Madrid.
- Digitisation projects differ significantly in terms of quantity, characteristics of material to be digitised and required quality. This obviously translates into significant differences in cost per unit.
- These differences largely depend also on the local market situation and price structure, but most importantly on the quality requirements, as the largest percentage of the costs are labour, mostly for image and sound restoration.

As a result, the study had to generate its own cost models that are largely based on information that were disclosed to the authors under conditions of confidentiality, and on the authors' direct knowledge of the dynamics of market and the technology.

2.4.2   The size of collections

A first issue is the quantity of materials that are held in the European FHIs, for which precise figures do not exist.

In 2010 in its Survey on Orphan works[56], the ACE (Association des Cinémathèques Européennes) estimated that *"the total number of film works held in 24 archives is ca. 1.064.000"*. The 24 archives mentioned are those that replied to the ACE survey, so the figure is precise, but it does not cover all institutions holding film collections, plus the figure is in 'works', and this needs to be translated into running time for practical reasons.

The recent study "The Cost of Digitising Europe's Cultural Heritage" prepared by the Collections Trust for the report of the Comité des Sages[57], estimates that *"there are approximately 1.03 million hours of Film in European cultural institutions."* The estimates are based on the results of the EU project TAPE-Training for Audiovisual Preservation in Europe[58], the focus and competence of which was really on 'audiovisual' collections rather than cinema. As a consequence, the category 'film' includes also broadcasters' collections (mostly news shot on 16mm), but has the advantage of surveying cinema collections across a wider spectrum of institutions, not only specialised collections (as in the case of the ACE survey).

In conclusion, considering that

---

[56] Results of the Survey on Orphan Works 2009/10 http://www.acefilm.de/102.html
[57] http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/17
[58] http://www.tape-online.net/survey.html

- The 1 million works listed by the ACE include materials of different duration, and that if an average of 30 minutes is used the 24 archives' collections would amount to 500,000 hours;
- This figure refers only to a small number of archives. Although they are the largest film collections in Europe, they do not account for all the cinema holdings.
- On the other hand, the total includes also non-European films, and obviously there is a high ratio of duplication, i.e. of works that appear in more than one FHI.
- The TAPE survey includes more categories of institutions, but it does include also broadcasters, thus increasing significantly the total. On the other hand, the TAPE survey covers only in part the major FHIs.
- If 1M hours is retained as a ballpark number on which to base indicative projections, this would translate into an average of 37,000 hours of cinema content to digitise per MS.
- The figure of 37,000 hours on average does not seem to be excessive, considering that it includes not only feature films but also shorts, documentaries, newsreels etc.
- Finally, it is not realistic to assume that all works will be digitised only once, in one country; of course this would be advisable, but it is more realistic to assume that some degree of duplication will continue to exist. Besides, FHIs might need to store and preserve localised (i.e. dubbed, subtitled, etc.) versions of works from other countries. If we assume a 20% duplication factor, this brings the total of unique works to be digitised per MS to 30,000 hours, which seems a reasonable figure.

All this considered, **this study assumes 1M hours as an estimate of the quantity of cinema materials held by FHIs in Europe**. It is necessary to stress that this figure is most probably calculated in excess (probably of about 15-20%). Nevertheless it seemed prudent for this Study to use an estimate that is at the top end of the spectrum of possibilities.

2.4.3   Digitisation costs

As discussed previously, 'digitisation' is a rather generic term employed to define a rather wide range of activities and workflows.

Digitizing a positive print for online access or an original camera negative for D-Cinema distribution might require different equipment, and they definitely require a different amount of specialised manpower. As a result, 'digitizing' costs in one project can be a hundred times higher than in another.

So, using the above example, the cost of a simple scan of a positive print can be as low as €400 per hour of scanned material[59]; but as an example of a high quality project, the cost of €40,000 to €50,000 is given as an average cost of restoration of one feature film in the framework of the previously mentioned French government initiative[60].

---

[59] Price indicated by one of the respondents for lab costs in a Western European market. It was not even the lowest price reported.
[60] See "Le patrimoine plonge dans la numérisation" in Le Film Français, May 17, 2011 p.6

In order to calculate the cost of digitizing the European film collections, the previously mentioned "The Cost of Digitising Europe's Cultural Heritage" uses the figures provided by the PRESTOPrime project[61]:

> *As a rule of thumb, anything involving film would cost roughly ten times as much as a similar operation on videotape. Videotape copying and digitisation had a benchmark cost of €100 to €200 per hour, and film-to-film copying or film scanning/digitisation was indeed running at €1,000 to €2,000 per hour."*

Within this study, a costing model was designed in order to define a realistic cost per hour for a mass digitisation project for the whole European cinema. The model is built around some hypothesis:

- Equipment costs are calculated for one 'digitisation unit' built around one scanner capable of 2k and 4k resolution, designed for archival materials and capable of scanning both 16mm and 35mm. The rest of the equipment is calculated to support the throughput of the scanner. In other words, the number of ancillary equipment is calculated based on their productivity against that of the scanner.
- The model takes into consideration down time, maintenance costs and depreciation
- Costs of facility, i.e. the workspaces, are not included as they are too variable. Besides, many FHIs might already have available workspaces, and the surface required for such operation is not large.
- Overheads are calculated as a fixed percentage of the investment on equipment.
- Processes included in the model are: physical preparation of the elements to be scanned, scanning, sound digitisation, colour correction, image and sound restoration, basic editing, quality control. (Encoding is not calculated as it has a very limited impact on personnel and equipment costs).
- Personnel costs are calculated for one shift of 7.5 hours per day and 1400 working hours per year, as no FHIs seems to be working on double shifts. The number of staff is also calculated based on the maximum output of the scanner. It is important to point out that going to two shifts would mean a significant improvement in the ratio between productivity and investment, thus reducing the digitisation costs in a non negligible way; nevertheless this option was not taken into consideration as it was considered unrealistic for many FHIs that are public institutions.
- The model does allow for three quality levels. It is important to point out that none of these levels refer to a full-blown, top-level, multi-month restoration project as the concept behind the model is a mass digitisation project with a significant throughput.
  - Basic: 2k scanning, limited colour correction and very limited restoration
  - Medium: 2k scanning, higher colour correction (coherent with the scanning of an inter-negative) and medium image and sound restoration
  - High: 4k scanning, colour correction calculated for an original camera negative, higher image and sound restoration
- The model allows calculating the cost per digitised hour of material according to the hypothesis that foresees different percentages per each quality level. In other words it is possible to simulate the costs of a project that include – for example – an output of 60% basic, 20% medium and 20% high quality levels. Different percentages would result in different costs per hour, and productivity levels.

---

[61] PRESTOprime Audiovisual Digitisation Status Report (Wright, Richard), January 2010

- The model was validated against figures derived from ongoing or planned projects with positive results.

After this assessment, several simulations were run through the model, the different simulations tried to be as realistic as possible, for example, none of the simulations included a 100% 'basic' quality level, nor a 100% 'top quality' level, as reality on the ground shows that there is always a differentiation according to the individual title, and conditions of the film, as it assumes a mix of few feature films with high cultural or economic value, a reasonable amount of 'average' titles, and a larger number of material where a high output is the main aim (as documentaries, newsreels, shorts, etc.).

The results of these simulations partially confirm the estimates of the PRESTOPrime project, but with interesting results. The top end of the range is confirmed at around €2,000 per hour of digitised material (70% at high quality, 30% medium in the study's model). The interesting result is that the model indicates that 'basic' digitisation projects can reach lower per-hour costs, lower than €800/hour while maintaining an overall good quality as the model still allows for colour correction and some amount of restoration. Really 'basic' digitisation projects aimed at very high throughput (with minimum colour correction, limited processing and no restoration at all) can reach a per-hour cost as low as €500/digitised hour.

In short, the cost model adopted for digitisation projects (again, it is necessary to stress that this is not for top-quality restoration projects) show that per-hour costs range between €500 and €2,000.

If these figures are then applied to the 1M hours representing European FHIs' collections, we reach a cost for the digitisation of the whole European cinema heritage between €500M and €2B as a maximum, a 'worst-case scenario'.

At this point it is important to point out that the €500M to €2B figures refers to a 'worst-case scenario', i.e. **the maximum cost**. First of all the figure of 1M is in itself chosen in order to 'err in excess', and secondly it is fairly obvious that the target of digitizing the whole EU heritage is not necessarily a realistic one. Selection criteria will have to be applied, and it is reasonable to assume that a percentage of the collections will not be digitised.

To test to what extent the figure is reasonable, we can go back to the figures mentioned in regard to the recent French Government's digitisation figures. If we apply the figure of €40,000 per film and we see how many films can be restored at that level with the available amount of €2B, the results are that 25,000 two-hour European feature films can be restored at a €40,000 per film, leaving approximately €1B, enough to digitise 800,000 hours of cinema works at a cost of €1,250 per hour, which is the average cost range the study's model proposes.

In other words, taking €2B as the overall cost of digitising the European film heritage would allow a very diversified mix of high-end restorations and high-throughput basic digitisation projects, which seems to correspond to the current plans and activities of most FHIs.

The combination of the abovementioned factors leads to a *realistic* figure for the overall costs of digitizing the collections of the European FHIs that is around €1B. This €1B is to be considered as spread over a period of a

few years, with 7 to 10 years seeming a good compromise between urgency, technical constraints and reasonable productivity targets (based on ongoing mass digitisation projects).

As a point of reference, €1B corresponds to approximately 37% of the aid that Members States invest in the cinema industry in one year only.

Summary

- Quantity of cinema materials requiring digitisation in Europe is calculated in 1M hours. This figure calculated as 'worst possible scenario'.
- The cost model adopted for digitization projects show that per-hour costs range between €500 and €2,000
- Digitization costs for the whole European cinema heritage are then calculated at **between €500M and €2B in the worst-case scenario**.
- **A more 'realistic' projection focuses on a cost of around €1B, spread over a period of several years**.
- €1B correspond to approximately 38% of the aid that Members States invest in the cinema industry in one year.

3. Challenges and opportunities

3.1 Collection

3.1.1 Current situation

As shown in the Commission's reports, most EU countries have some sort of compulsory deposit for cinema works. These differ in terms of works that are subject to the deposit (all national productions vs. only productions co-funded by public bodies), and in terms of materials that must be deposited (release prints only or master elements as well, and in this case the deposit of the master elements can be different in time – e.g. few years after release).

According to information contained in the "Second Implementation Report of the Film Heritage Recommendation"[62], structured and organised deposit of cinematographic elements exists in almost all MS. These take the form of legal deposit (in 11 MS) or of compulsory, contractually-bound deposit for publicly funded films (in 16 MS)[63]. Only the Netherlands and the UK rely almost exclusively on voluntary deposit (UK has an exception for the films co-financed with Lottery funds). Very few countries, such as France, require the deposit of all movies distributed in the country.

This is not the case in the United States, where compulsory legal or contractual deposit does not exist. Producers often deposit prints (and sometimes masters) voluntarily, and major studios are all actively engaged in long-term preservation of the productions they control, either new or 'archival'.

Although at first glance this could appear as a positive picture, a careful analysis of the answers show that in most cases the materials that are required for deposit cannot be considered elements that are appropriate for long-term preservation (in other words negatives, internegatives or interpositives for analogue productions, and digital masters for D-Cinema distribution). In most cases a positive print (and in one case even a standard definition video version) is considered to suffice for deposit. In France, for instance, producers are required to deposit a positive element, while they are 'encouraged' to deposit negatives or other preservation-grade elements.

The situation concerning the deposit of Digital elements is that this is regulated by contract in the case of deposit of publicly funded works, while in many countries the text of the law is generic enough to allow the FHIs to require the deposit of a Digital master. In some countries though (this is for example the case in France), the law clearly refers to one or another analogue element, and in these cases laws should be amended to allow the deposit of digital materials.

---

[62] First Implementation Report of the Film Heritage Recommendation, SEC(2008) 237 of 4.08.2008, http://ec.europa.eu/avpolicy/docs/reg/cinema/report/swp_en.pdf
Second Implementation Report of the Film Heritage Recommendation, SEC(2010) 853 final of 02.07.2010, http://ec.europa.eu/avpolicy/docs/reg/cinema/report_2/2010_853.pdf
[63] The mathematics of these figures is skewed due to the fact that Belgium appears twice, with the French and the Flemish communities.

Often the national film archive is the body entitled to define what digital or analogue elements are considered acceptable for legal or contractual deposit, and this was the main reason behind the above-mentioned FIAF Recommendation. Information gathered within the study shows that almost all FHIs are seriously concerned with the issue of adapting legal or contractual deposit law and regulations, but those in the process of introducing or implementing these amendments are all confronted with resistance to deposit any unencrypted digital element.

As it was confirmed during the interviews conducted for this study, producers and distributors are opposed to any sort of compulsory deposit. The rationale for this is that they add to the costs and add a layer of bureaucratic procedures required in order to access the market. Even more importantly, producers are seriously concerned of the potential risks of digital piracy if they deposit a master with a FHI. This is a concern that the FHIs should take seriously if they want to obtain digital unencrypted masters in deposit.

When analysing the situation depicted by the "Second Implementation Report", another source of concern is that long periods are often allowed (up to 24 or 36 months) for the deposit of the 'master elements'.

This was of course justified by a concern to reduce the costs the producer had to face in order to deposit printing elements (inter-negatives or negatives). Such provision in fact allows producers to deposit their printing elements only after their 'commercial life' has expired, in other words when they are not needed anymore for printing, or scanning. Thus the producer could save the costs of producing a printing element 'just' for deposit.

In the analogue era this provision was clearly a reasonable compromise to alleviate the burden on the producers (as it usually meant any deposited preservation element was 'used' and potentially showing signs of 'wear and tear').

Now, in a digital environment, the main rationale for this provision is not valid anymore as the deposit of a digital master has negligible costs for the depositor (more precisely, they are limited to the cost of transferring files onto a hard drive, and the hard drive itself – to be calculated in the hundred euro range).

But beyond being not necessary, the provision is extremely harmful in terms of digital preservation. In fact the risk of problems after waiting two or three years before receiving a digital object is very high as the condition in which the media will be in at the time would be uncertain and there might be issues with the format, the integrity of the files and, almost certainly with the key in case of an encrypted file.

Whether legally required deposit is in place or not, voluntary deposit is still a major source of acquisitions for public FHIs. It should appear clear that the whole model of voluntary deposit is facing challenging times. Producers and distributors are aware that film elements require space and need proper conditions for long-term conservation, and they are already used to depositing voluntarily their films with FHIs. But Digital is different. It does not take much space (a few hard drives or LTO tapes for the master, and a few are sufficient for the DCPs, and dematerialisation in the sense of direct delivery without hard drives to the theatres for example via satellite is growing fast, so physical copies are not even needed), awareness of the problems of digital preservation is low (see the

appropriate chapter below), and finally the concern for piracy is very high. The result is that it is almost certain that voluntary deposit will decrease to a minimum in the coming years, and if it happens at all, it will be in the form of an encrypted DCP, which is completely useless in preservation terms.

As a closing remark on voluntary deposit, it is worth noting that there is overwhelming evidence supporting the almost unanimous opinion from FHIs that voluntary deposit is not an effective way to secure the deposit of a national cinema heritage. Voluntary deposit has a tradition of being effective in domains where it has been traditionally in place (as in the case of libraries), but this does not apply to cinema. All FHIs acknowledge that whenever a legal or contractual deposit is not in place (or in periods when historically it was not in place), their collections are not complete and a significant amount of titles are not deposited (which, for older productions, means that they are most probably lost forever). In short, voluntary deposit works only to some limited extent, unless there are strong and compelling reasons to encourage it in an effective way. One example in this sense is the current situation in the Netherlands, where voluntary deposit works well, and this is probably due, at least in part, to the closer relations with the industry due to the ongoing "Images for the Future" project that, we recall is focused on the digitisation of, and access to, the whole national cinema production.

In this context it is critical to remember the earlier point made concerning the structural weaknesses of the European cinema industry. In most cases, production and distribution companies are not just small in size, but often they are also short-lived as they either fold, or undergo mergers and restructuring rather often. Multinational co-productions are also the rule in Europe, with ownership of the rights and of the physical elements (negatives, inter-negatives and prints) being often shared by many companies in many different EU countries, which complicates the issue of voluntary deposit already in the analogue domain, and it is likely to become even more challenging in the digital era.

Obviously this differs dramatically from the situation in other markets of comparable sizes, as the US or India, where large companies control the majority of cinema works distributed. Production companies are often very large in size and therefore have larger budgets to dedicate to the preservation of their 'assets'. Clearly, there are a significant number of independent productions also in the US, but their incidence is dramatically smaller than in Europe: there they can be considered the exceptions, while here they are the rule.

As a result, the Hollywood studios are all investing significant human and financial resources in projects focusing on Long-term Digital Preservation (LTDP), either directly (as per informal workgroups among within or across studios) or indirectly, e.g. via the Academy of Motion Picture Arts and Sciences (AMPAS - which was responsible for the seminal study "The Digital Dilemma"[64] in 2007).

No such activity can be reported in Europe, at least not at such a high level and intensity. Investments in the field of long-term preservation are left to national archives, and currently practically all digital masters are sitting in one digital

---

[64] The Digital Dilemma, AMPAS Tech Council (2007), http://www.oscars.org/science-technology/council/projects/digitaldilemma/

post-house or another, or in D-Cinema service providers (at least until the day they will start charging for the service).

Almost invariably in all FHIs, acquisition policies and procedures, either via compulsory legal or contractual deposit or via voluntary deposits, or simply as internal procedures at commercial FHIs, are still largely designed for analogue materials.

But more generally, and beyond the technicalities of the different laws, European FHIs are usually not equipped to correctly and fully handle the ingestion of digital materials into their collections, as they largely lack the necessary equipment and/or the know-how and staff to verify the materials at the moment of ingest, not to mention the metadata schema to describe them correctly.

In fact, the issue of "technical metadata" for digital materials is considered critical by many archivists; a significant amount of work is undergoing in the US within the studios, while no such activity is to be seen in Europe.

It has been noted that for a FHI to process correctly a digital element at ingest (i.e. at the moment of the deposit) a FHI should:

a. Receive in deposit materials that the FHIs can check, i.e. that are not encrypted; if encrypted, a key that allows to completely de-crypt the content (the so-called Distribution key or Studio Key) is to be delivered;

b. Have adopted a comprehensive metadata schema allowing to record the technical characteristics of the digital object (both at ingest and all along its life cycle, including at migrations);

c. Have acquired the proper hardware / software tools necessary to inspect, analyse, check the digital objects at ingest and all along its life-cycle;

d. Have the necessary know-how within its staff to apply the above to the many digital formats that are being, will be, or might be ingested;

It should be clear that issue (a) can only be solved by creating within a FHI a 'trusted environment' that the holders of the materials can consider to be completely and absolutely secure to protect their materials, and by encouraging FHIs to create such an environment and content-holders to take advantage of it.

In other words, this is not (or not primarily) a budgetary issue, but a 'political' issue in the relationships between content holders and FHIs, where the two parties need to reconfirm the trusting relationship they had for years in the analogue era. After all, all film material deposited in FHIs is 'unencrypted' by definition, and FHIs are definitely not the source of pirated copies (as a matter of fact, piracy derives either from camcording, distribution copies such as DVDs and such, or from laboratories or even from within the production or distribution company).

A 'trusted digital repository' is not a new concept, as there is a wealth of literature and experience on the topic in the IT domain. A good source of reference is a

report from the EU project CASPAR[65] specifically dealing with the issue of 'trusted repositories':

> The OAIS model[66], is now adopted as the "de facto" standard for building digital archives (NSF, 2007). Section 1.5 of OAIS (Road map for development of related standards) included an item for accreditation of archives, reflecting the long-standing demand for a standard against which Repositories of digital information may be audited and on which an international accreditation and certification process may be based. It was agreed that RLG and NARA take a lead on this follow-on standard. This they did, forming a closed panel which produced Trustworthy Repositories Audit & Certification: Criteria and Checklist (TRAC, 2007). TRAC was based on two documents, namely the OAIS Reference Model (OAIS, 2002) and the Report on Trusted Digital Repositories: Attributes and Responsibilities (RLG-OCLC, 2002).

Based on such literature, and on several relevant ISO standards (among them: BS ISO/IEC 27002:2005, BS 7799-1:2005, BS ISO/IEC 17799:2005 Information technology. Security techniques. Code of practice for information security management or BS ISO/IEC 27001:2005 Information technology. Security techniques. Information security management systems requirements), as well as on the experiences of implementation of digital repositories for digital masters in several service providers across Europe and the US, it is far from impossible to design and implement a trusted repository holding D-Cinema content.

The real issue (like the other three in the above list) is the possibility for FHIs to acquire the necessary resources in order to acquire the know-how and expertise on this and all other issues: Staff needs to be trained, or new staff hired; equipment must be purchased; work on metadata standards must be carried out.

It is also necessary to point out that actions in this field are quite urgent, as the saying goes, they are needed the "day before yesterday", as roughly half of the FHIs that responded to the study's survey declare that they already receive digital formats in deposit (legal or voluntary), the other half expect to start receiving them in the next 12 months, and they all declare that they are not completely equipped to do so.

Once more, the problem is not coming, it is already here.

Summary

- All MS have structured systems to collect cinema work (legal or contractual deposit). Only two rely on voluntary deposit only.
- Nevertheless the requirements are not sufficient to ensure long term preservation, and need revision in almost all MS.
- There is enough evidence that voluntary deposit is not effective in collecting cinema works
- In general, FHIs do not possess the equipment, the staff and the know-how to ingest digital content
- In order to be able to collect unencrypted digital materials, FHIs must see to implement 'trusted and secure repositories'
- Actions are needed immediately, as digital content is already being deposited in FHIs.

---

[65] Report on Trusted Digital Repositories, Deliverable from the CASPAR (Cultural, Artistic and Scientific knowledge for Preservation, Access and Retrieval) Project, 2009
[66] Reference Model for an Open Archival Information System (OAIS, ISO 14721:2003)

3.1.2 Future possible scenarios

Acquisition of digital formats has already started, despite the fact that the "FHI system" is not fully ready yet – and this is not a surprise as the main motor of change in the industry is production, and not long-term preservation.

Digital acquisitions are also expected to grow exponentially, and at a very fast pace, as we consider that in 2010 some 1200 feature films were produced in the 27 EU countries[67]. Assuming similar figures for 2011, and knowing that almost all of current productions end up with a digital master (with or without a version on film), this means that the FHIs will be facing a significant input of digital masters and copies in the coming 12 months.

Without the proper equipment, staff and know-how the future preservation of these works is seriously endangered.

At the moment the predominant model with European productions is that D-Cinema masters (DCDM – Digital Cinema Distribution Master) and the DSM (Digital Source Master) from which the DCDM is derived are delivered to the client, i.e. the producer, either on LTO tapes or on hard drives.

For 1200 films this amounts to a significant quantity of data produced annually in Europe.

Exact figures are not available, but the projections produced within the study (see following chapter on Digital Preservation) indicate an annual growth of some 5.8PB[68] per year, assuming that only one version of each film is retained, and that no rushes and outtakes are kept. If multiple versions are retained, together with rushes and outtakes, conservatively calculated at 5 times the running time of the finished work, and assuming that mechanisms are put in place to encourage or mandate the deposit of all digital materials, the figure can reach 30PB / year EU-wide.

This figure is most probably underestimated, as one major US studio executive calculated that it had received approximately 9 PB of data in 2010 (not counting digital video versions for TV distribution).

On the other hand it is not common for FHIs to retain outtakes and rushes, and it is realistic that these will not find their way to the archives, at least in the foreseeable future. Even if we stay with a figure of approximately 6PB/year, we end up with FHIs having to ingest 6PB of content every year, or store and preserve securely and safely at least 30 PB of data every five years.

Again, this does not include video distribution versions, nor any digitised material, but only the new, born-digital masters.

There is no doubt that such a scenario will put under considerable pressure both the industry and the FHIs across Europe, if we consider that the costs of storage is

---

[67] Figures from the European Audiovisual Observatory
[68] 1 Petabyte = 1024 TeraBytes or 1.048.576 Gigabytes

just one of the many components in a long-term preservation strategy, and not even necessarily the most important.

The major concern in terms of ensuring that the thousands of films produced over the next years in Europe will survive is that they find the way to a FHI in a timely and efficient manner.

Frankly, with the considerations we expressed earlier about the characteristics of the European cinema industry, it is critical that digital masters are acquired and correctly stored as soon as possible to avoid dramatic losses and the chances that this task is taken up completely by the industry are not very high.

Also, it is important to remember that the costs of producing digital copies to be deposited in archives is basically zero when compared to the costs of producing an extra inter-negative (which costs around €25-30K) or even an extra analogue positive print (€1K) for deposit. In other words, the actual cost of multiplying the preservation strategies by storing one master at a FHI is almost zero when compared to the risk of losing completely a valuable asset. As always in an IT environment, keeping multiple copies in multiple repositories is the best strategy.

On the other it is important not to underestimate the security factor in any discussion about deposit of digital copies. On the one hand the cinema industry is seriously concerned by piracy, and on the other it is presented with a solution (encrypted DCPs) that offers total control of the work as well as total security against unauthorised use. Also, awareness of the risks and challenges posed by Digital Preservation is still limited, and it is not unusual to encounter in the industry and at political level the myth that digital is easier and more economical to preserve.

Furthermore, the number of works that are managed and stored at production companies and external laboratories is not yet too large, and the industry has not felt the bite of the costs involved in digital preservation. Also this is not going to last very long. Service providers in Europe and in the US are starting to realise that many of the digital materials they hold in storage do not produce any revenues anymore, and they are starting to ask to be paid to maintain them. At best they hold titles for a few seasons, maybe two- three years, but when the catalogues become much bigger, 4-5 years down the line, digital storage and management of digital collections will become expensive for the industry, and the risk is that the costs will make digital preservation unsustainable for small producers, and that many works will not be conserved.

All these factors make it difficult at the moment to have an open discussion about the possibility, the opportunity and even the economic advantages of depositing digital masters with FHIs' secured repositories, thus increasing the danger of losing a significant number of works produced in these transitional years.

Summary

- Based on a projection of 1200 feature films and 1400 short films produced every year, the amount of data can be calculated between 5.8 and 30PB/year. 5.8PB will be taken as reference in the Study.
- For producers, the cost of depositing a digital master in a FHIs is insignificant
- Currently, D-Cinema masters are stored for free at service providers, but this is already changing and soon they will charge or dispose of the materials.

3.1.3   A cost / benefit analysis

The cost of Long-term Digital Preservation of the newly produced cinema works, and the digitised collections held by European FHIs is discussed in depth in the following chapter, to which we refer.

If we jump to the bottom line of that chapter, we reach a projected cost of €250K per PB per year for a fully redundant 20 PB archive, which should be sufficient to safely store the coming 3 years of European cinema production at an overall running cost of €5M.

As explained in the relevant section, these figures assume the creation of a storage infrastructure capable of storing also the result of digitisation. If we have to assume that NO digitisation will ever take place and that only newly produced need digital preservation (a very unlikely scenario, to say the least), the economies of scale would be lost and it would be safer to multiply these costs fourfold. This would result in preservation costs that are still moderate, in the range of some €6M for the whole European film production of one year.

Unfortunately, precise figures for the commercial value of 'catalogue' film assets, i.e. films that are 5 or more years old do not exist as all available figures area aggregate for 'cinema content'.

Still, some figures give some ideas about the dimensions of the market for cinema content. We could for example limit our example to VoD, which is the smallest of the markets for cinema works, after home-video and TV. As we mentioned earlier in this study, cinema takes 62% of all viewing time spent on pure VoD channels. European Audiovisual Observatory figures indicate that the VoD market in Europe is growing fast, with 700 channels producing revenues for more than €600 million in 2008 that are projected to grow beyond €2B in 2013. If we conservatively attribute half of these revenues to 'pure VoD channels' (as opposed to 'catch-up' broadcasters VoD services that are usually focused on entertainment programs and news) and we apply to it the 62% figure, we end up with a value for cinema content (that is predominantly 'archival', i.e. catalogue titles and not new) on pure VoD channels of €186M in 2008 and €620M in 2013. Obviously this includes non-EU titles. But even if we apply a share of 25% for EU cinema based on box office revenues, we still see that the value in the smallest of the market sectors was almost €50M in 2008 and will be more than €150M in 2013.

We can look at the cost of LTDP of cinema content against the real investment of the MS in the cinema industry, the €2.6B/year that was quoted earlier. LTDP, which in this case can really be seen as an 'insurance on investment' would represent only 0.23% of the yearly investment.

Obviously, this analysis does not even take into account the most important aspect, albeit the most difficult to 'monetise': the cultural loss that would entail the loss of even 20% of the yearly European cinematographic production, which is virtually irreplaceable.

Summary

- According to the Study's cost model, preserving the new cinema digital productions in a digital repositories, would cost €1.5M/year
- Even by multiplying this by a factor or 4 to allow for FHIs to get equipped, the cost would still be only 0.2% of what the MS invest in supporting the cinema industry.

3.2 Storage and Long-term Preservation

3.2.1 Introduction

Cinema's transition from an analogue to a digital medium is perhaps the most significant change since the film industry standardised on the 35mm film format in the early 1900s. By the end of 2010, one third of Europe's cinema screens have been converted to digital projection[69]. This rate of progress leads to the conclusion that conversion to digital projection will be substantially complete in the next two – three years.

Digital 'islands' have existed since the 1980's, starting with post-production and visual effects work. However, up until relatively recently there has always been a 'return to film' with the results of digital processing being delivered as analogue images on analogue film.

Developments in digital imaging and capture, storage, and networking technologies have reached the point where complete works can now be produced digitally. As equipment and techniques mature, an increasing percentage of works will be completely 'born digital'.

The remaining mandatory 'analogue' step in the chain from creation to display was the film distribution circuit. With the standardisation of the DCI system specification[70,71], development of viable financing models and projection equipment, the transition to digital exhibition is well underway in Europe and in the rest of the world[72].

The resulting dematerialisation of cinema content will have a profound impact on the way in which existing and new material is preserved, both for conservation and for access.

The completion of the transition to digital for production and exhibition has potential to trigger a number of events, which directly impact the preservation of cinema heritage:

Analogue film prints become generally unavailable and most new works exist only in digital form.

The creation of an analogue film print for preservation is no longer an incremental cost on the back of a distribution print run.

The long-term future of analogue film stock becomes uncertain. Volumes will decrease, costs will increase, and there is no guarantee of continued availability of types of film stock and processes at the current standard of quality.

---

[69] "Europe: digital screens more than doubled in 2010 with 3D once again the driving force", European Audiovisual Observatory Press Release, 12th May 2011.
[70] DCI Specification version 1.2, March 2008., Digital Cinema Initiatives LLC.
[71] Society of Motion Picture and Television Engineers, Technical Committee 21DC Digital Cinema.
[72] "Tracking When Film Distribution Ends", Michael Karagosian, Digital Cinema Report #192, March 15, 2011.

The collapse of the analogue film value chain will adversely impact availability and developments of equipment for the creation and exhibition of analogue film.

3.2.2 Analogue Preservation

The preservation of analogue film has a long tradition and a significant amount of research to support practices that are applied by all FHIs across the world (to the limits of their budgetary resources, obviously).

Life expectancy (LE) of film material stored under proper conditions is extremely high

Life Expectancy	Storage conditions		
	Bagsværd Fort (10°C, 80 % RH)	5°C, 30 % RH	-5°C, 30% RH
Fresh film	70	500	2000
Decaying Film	10	200	500

Table 3: Life expectancy for fresh and decaying films under different storage conditions.

according to a wealth of research mostly carried out by the Image Permanence Institute in Rochester (NY)[73]. The following table, derived from "Preserve and then Show" (2002) a publication of the Danish Film Institute show the life expectancy, in years, of different types of film materials under different storage conditions.

What should be stressed is that the table shows how long life expectancy can be achieved only under fairly strict conditions (+5° to -5°C) that clearly would seriously limit access to the elements, thus making them suitable only for long-term preservation as masters, negatives etc. Access materials by definition have a much shorter lifespan.

The same article contains an interesting calculation of costs of utilities necessary to store the whole collections of the Danish Film Institute under the best conditions. The summary of the results is given in the table reproduced below. Clearly, the costs calculated refer only to utilities and do not take into consideration other costs, such as facilities or staffing, and they refer to the Danish climatic conditions, of course. Still, they are extremely interesting in indicating an order of magnitude that FHIs have traditionally faced when dealing with Long-term Analogue Preservation. The final average utility cost per film title is less than €9 /

Material (storage climate)	Power consumption, new storage[3]
Nitrate (-5°C, 30% RH)	770.000 kW/yr.
Preservation materials[4] (+5°C/-5°C, 30% RH)[5]	400.000 kW/yr.
Prints for screening (+5°C, 30% RH)	87.400 kW/yr.
Total power consumption	1.257.400 kW/yr.
Total number of film titles in the collection in 2002	31.000
Power consumption/film title	41 kW/yr.
Passive preservation costs/film title/year.[6]	62.00 DKK

Table 5: Power consumption and passive preservation costs/year.

---

[73] ht

year.

In conclusion the following can be stated:

- Long-term Analogue Preservation is a well established discipline with a significant history and experience, and it is also well known to FHIs around the world.
- At proper conditions, analogue films can be conserved virtually forever, up to 500 or 2000 years depending on their support and conditions
- Overall costs of analogue film preservation are fairly reasonable (basically utilities and facility costs) and have allowed FHIs to operate until now on fairly low budgets
- Such low costs and long life expectancy can only be achieved for materials with an extremely low circulation, in other words masters and negatives that are rarely accessed.
- Access copies cannot be easily kept under such strict conditions, and they are subject to wear and tear, as a consequence their LE is much shorter and costs of replacement are high[74]
- Long-term Preservation of analogue film elements is therefore neither problematic nor particularly costly, but this is strictly limited to non-circulating masters.

3.2.3   Digital Preservation

The preservation of digital works, either born digital or digitised, is at a very early stage of maturity by comparison to film. No digital storage technology exists with a lifetime comparable to analogue film separation masters. There is no experience with managing collections that are purely digital in form over the same timeframe as film archives, yet the pace and economics of the transition to digital oblige solutions to be found or to risk irrevocable loss of digital film heritage.

Digital technologies have the potential to offer hitherto unprecedented levels of access to cinematic heritage. Digitisation and dematerialisation of film media allows potential for transparent and accurate preservation of digital works, either those born-digital or analogue works that have been digitised.

Organisations responsible for the preservation of cinematic content will need to adopt strategies for managing both digital and analogue content or be relegated to

Summary

- At proper conditions, analogue films can be conserved virtually forever, up to 500 or 2000 years depending on their support and conditions
- Overall costs of analogue film preservation are fairly low
- Long Term Preservation of analogue film elements is therefore not problematic nor particularly costly, but this is strictly limited to non-circulating masters.
- The preservation of born-digital works in a digital environment is not assured. It is unclear who will bear the costs of data preservation, or whether a viable economic model will be found.
- The transition to digital presents a risk not only to the preservation of born-digital works, but also to the continued preservation of existing archive collections.
- Roadblocks to digital preservation and subsequent digital migrations need to be removed.

[74] ... d ... n be e ...

managing a collection from a certain window of time in the history of cinema.

3.2.3.1 *Preservation is a system, not a technology*

Successful preservation requires a systematic approach to be adopted, regardless of the physical form of the archive to be managed. Policies and systems for the management and preservation of physical collections are well established.

The transition from the management of physical collections to the management of intangible data presents particular challenges. For example, how is material catalogued? How can content be stored and later retrieved? How is it possible to monitor the state of the stored material to ensure there is no degradation over time? How is it possible to ensure that items stored in a digital archive can be recovered and the original representation restored?

The first industry segment to be confronted with the challenge of preserving large amounts of high value data in intangible digital form was the space industry. Recognition of the high acquisition cost, long-term value, and uniqueness of data acquired through various space programmes resulted in the production of a Reference Model for an Open Archival Information System (OAIS) by the Consultative Committee for Space Data Systems (CCSDS)[75].

The OAIS reference model provides a conceptual framework for archive systems. It provides common definitions of terms, high-level concepts, functional models and definitions of mandatory responsibilities required to inform the design of system architectures and the development of systems and components. It is not a blueprint for system design, nor does it ensure consistency or interoperability between implementations.

The usefulness of OAIS has been recognised and its concepts adopted in fields beyond the space industry. Implementations still represent an open area for research and development of intermediate level detailed models and specifications prior to implementation for the target archive.

Several projects are active in this field, such as CASPAR[76], CDPP[77], PAC[78], PILAE[79], SPAR[80] and others. Subsidiary standards have either been developed or are under development to harmonise aspects of the OAIS reference model[81].

The OAIS model is almost universally accepted as the reference model for digital repositories aimed at Long-term Digital Preservation (LTDP) in different domains and applications. The FHIs community has also adopted OAIS in many national and EU projects, as for example the previously mentioned EDCINE project.

---

[75] "Reference Model for an Open Archival Information System (OAIS)", Consultative Committee for Space Data Systems, CCSDS 650.0-B-1 Blue Book, January 2002, also adopted as ISO 14721:2003.
[76] The CASPAR (Cultural, Artistic and Scientific knowledge for Preservation, Access and Retrieval) European Union Sixth Framework Project : http://www.casparpreserves.eu
[77] Data archive for the "Centre de Données de la Physique des Plasmas".
[78] Project PAC, Centre Informatique Nationale de l'Enseignement Supérieur.
[79] Project PILAE, Plate-forme Pilote d'Archivage Electronique, Direction des Archives de France.
[80] Project SPAR (Système de Préservation et d'Archivage Réparti), Bibliothèque nationale de France, http://www.bnf.fr/fr/professionnels/conserver_spar.html
[81] For example PAIMAS (Producer Archive Interface Methodology Abstract Standard), CCSDS 651.0-B-1, ISO 20652.

Adopting a standardised and systematic approach to long-term data preservation is expected to bring advantages to the management and preservation of FHIs collections in the digital age:

- Interoperability for exchange and remote/consolidated search and consultation of catalogues in different institutions, allowing Europe-wide access.
- Formalised collection and sharing of expertise from individual competence centres.
- Shared storage redundancy between different FHIs as one means of providing geographical redundancy and data resiliency.
- Formalised planning and processes for managing the information technology aspects of digital archives, including the introduction of long-term planning of inevitable media and format migrations.

Each FHI will probably develop its own approach to managing the transition to digital. It is to be hoped that the hard-won experience from other industry segments may be capitalised upon during this process. To that purpose, this study includes a closer view on the Audiovisual and the Space Data sectors, in the Annex section.

3.2.3.2 Media and Format Migrations

Media migration is defined as the transfer of information, while intending to preserve it, from one support to another. The new information implementation replaces the old. In OAIS terminology, media migration discussed in this section covers refreshment, replication, perhaps repackaging, but excluding transformation which is covered in the section 'Format Migration'.

Whether media preservation is achieved using analogue (photo-chemical) or digital (information technology) means, four main motivators are seen to drive media migration of archival media[82]:

- Media decay.
- Media obsolescence.
- Increased cost effectiveness.

---

[82] "Reference Model for an Open Archival Information System (OAIS)", Consultative Committee for Space Data Systems, Blue Book, January 2002.

- New consumer service requirements.

To take an analogy from health care, preventive medicine is very cost effective as early diagnosis of problems results in less costly treatment and fewer complications.

An archive may contain both analogue and digital elements in its collection. In the case of FHIs four basic possible migration paths exist, as shown in the diagram.

A. Photochemical media migration:
This is the classic, and until recently the only, approach to film archive preservation. The film stock is preserved with a close approximation of its existing quality onto a new analogue support. No restoration is undertaken. Preservation of original image quality relies on the availability of modern film stock and processing having the correct characteristics to preserve the original image. Image characteristics such as film grain appearance will depend on a mix of the characteristics of both old and new film stock.

Longevity of the media will depend on the stability of the new film stock, the chemical processing and storage conditions.

As in all analogue duplication processes, loss of information (image or sound quality) is inherent in every migration process; it can be limited but not completely eliminated. Continued access relies on the film equipment 'ecosystem' remaining available.

B. Migration from film to digital support: This is the process of digitisation and is covered later. Digitisation is in fact a clear example of 'format migration'. Based on the above mentioned considerations about the preservation of analogue film materials, it is clear **that digitisation is NOT the most appropriate, cost/effective and efficient strategy for Long-term**

Possible media migration paths.

1   Migration from film support to film support by photo-chemical processing

2   Migration from film support to digital representation: Digitisation.

3   Migration from digital representation to film: Return to Film.

4   Fully digital migration
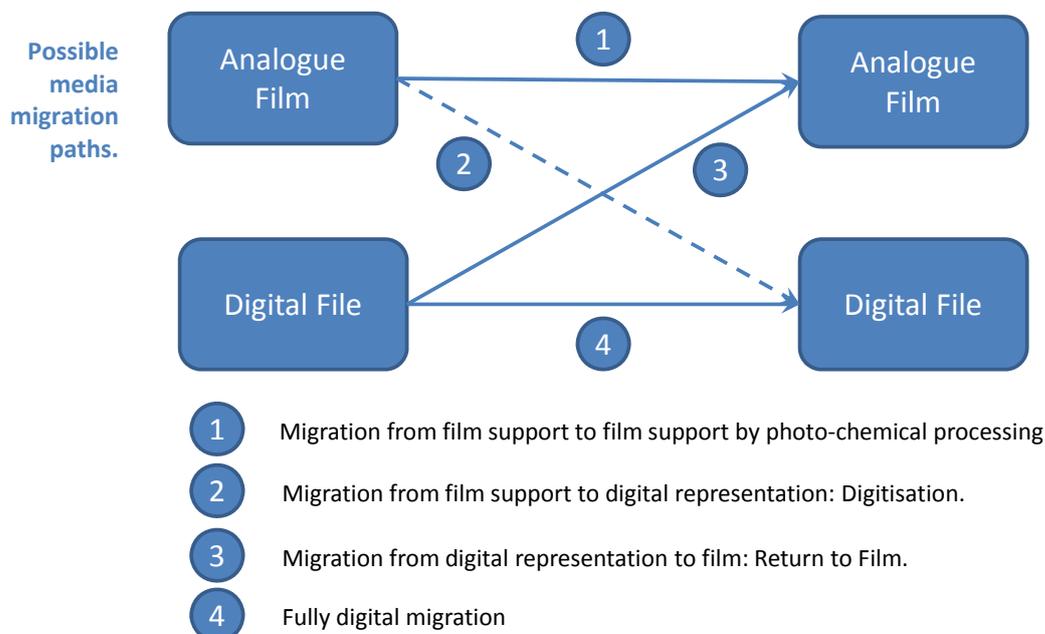
Preservation of the analogue cinematographic heritage. The function of digitisation is to make the works of the past accessible in a digital world.

C. Return from Digital to Film:

This option returns the digital archive element to a photochemical film based support. The risks of relying on a film based archive whilst the rest of the industry transitions to digital are covered elsewhere in this report.

Besides, a return to film of the result of a digitisation does not make much sense as the original film that was digitised will presumably last some 500 years (see above). The only eventual exception is the case where the film underwent a significant amount of restoration that is potentially at risk of being lost.

A transfer onto film of digital-only works (i.e. works that only existed in a digital format and were never distributed on film) does not ensure the preservation of the images as they were originally shown and experienced by the audience as the image characteristics of film and digital projection clearly differ. For this reason (and for the high costs), this model is clearly dismissed by virtually all FHIs.

The creation of so-called 'digital separations', i.e. the report on three black and white, polyester-based film of each individual colour channel (Red, Green and Blue), is an extremely costly (the order of magnitude is €100K per feature film) and technically delicate procedure that is in fact in use by the US studios for the preservation of their productions. The US studios employ this technique as part of an overall preservation strategy that also includes different digital formats. In this sense 'digital separations', or 'digital film-out' is never considered as the one preservation strategy, but really a sort of 'last resort' for a 'doomsday scenario'. The practice derives from a similar analogue process that has been in use for decades in North America and that has hardly ever been used in Europe.

However, during one single interview associated with the study, strong views have been expressed that the limitations placed on access to digital elements[83], driven by fear of digital piracy, might prevent FHIs from carrying out their responsibilities of content preservation.

The advantages of a return to film strategy may be summarised as:

- Return to Film is THE 'file and forget' approach. Funding gaps are survivable, and their impact is only perceived years into the future.
- Return to Film resolves the question of preservation which has been raised as an issue with encrypted DCP and DCDM packages.
- It also has the advantage of being psychologically 'easy' on archivists, who can postpone the day when they have to adapt to new technologies.

Disadvantages of this approach include:

- Back to Film does not aid access (either citizen or professional). A separate online archive must be held (if online access is provided) which is an operating cost multiplier.
- Going forward, the photochemical approach to multi-generation preservation is as unproven as the digital one, only the timescales are longer. The survivability of the film stock industry may be directly questioned in all fields over the next 10 to 15 years. Continued availability of preservation grade film stock, chemical processes and equipment is to be questioned if film disappears from all but the archival market and the

---

[83] Specifically, the concern expressed on several occasions is that the deposit with FHIs of a Digital Cinema DCP without a decryption key prevents the FHIs from carrying out its responsibilities to preserve content. The FHIs becomes a provider of storage space, and under these circumstances might prefer to receive a 35mm film print, maybe of a digitally restored work, rather than an encrypted digital copy.

value chain collapses. Return to film also requires that analogue film laboratories continue to operate at a sustained high quality, which, as we discussed earlier, is extremely unlikely perspective.
At the very best, this approach can be considered as a parallel strategy for the short term – possibly for the next 3-5 years.

- The long-term availability of high quality scanners to digitise digital images that have been transferred onto film is also in question, as is the cost in a future when film scanning will be limited to archival use.
- There is also a serious concern that such a strategy would only postpone the research, changes and investments that are needed to face the switch to Digital
- Costs are excessively high: around €25K for a film out on a single strip of film (Black and white for black and white films, colour for colour films), and in the range of €100K for digital colour separations. If these figures are applied to the European film production, they translate to yearly costs of €30M to €120M, or 20 to 80 times the costs of digitally preserving the same number of films (see Section **A cost / benefit analysis**).

D. **Digital media migration**: A lossless migration from one digital support to another. The digital content is preserved exactly. Motivators for migration may be renewal of the digital support or migration to a new technology for reasons of cost effectiveness or technology obsolescence. Migration should be transparent to the users of the system, without interruption of service.

In a fully digital archive, media migration may be automatic, lossless, transparent to the clients of the archive, and have a very low incremental cost. Digital Migration can be seamless and lossless, but it must be planned. Unplanned migration (whatever the reason, be it due to lack of foresight or unexpected media or equipment obsolescence or failure) is many times more costly than a planned migration.

Digital Migration allows continued access to the content by citizens and professionals under conditions that respect the rights of the content.

Digital Migration allows the possibility of managed distributed storage among the Member States as desired, with centres of excellence that not only provide direct access to skills and content, but that also allow for a distributed system architecture to be designed to allow for disaster recovery on a wide scale as well as multiple access points.

Cost models of full digital managed storage are converging for distributed, on- and near-line storage architectures (see Section **A cost / benefit analysis**).

3.2.3.3 Format Migration

For long-term data preservation, format migration presents a greater risk to the preservation of film heritage than media migration.

Format migration implies an irreversible transformation of content representation, either analogue or digital.

Given the risks that format migration presents for content preservation, what might be the drivers behind undertaking format migration?

Among the motivators driving format migration are:

- A format may be proprietary, without sufficient technical information to guarantee continued access beyond the obsolescence of current software tools.
- Access to the format may be limited by technical protection mechanisms such as encryption which prevent the preservation of content by a trusted archival institution.
- The format may have external dependencies such as hardware or operating system constraints, the lack of availability of which may prevent future access.

The format may be encumbered by patents which may limit the ability of archival institutions to manage the content and fulfil their (sometimes legal) obligations.

A work may be offered to an institution in a format that is not supported or that does not allow for preservation, in which case the format will need to be transcoded to a format that is supported.

To support strategic planning for the long-term preservation of digital content, the US Library of Congress is developing an inventory of information concerning the suitability of digital formats for long-term preservation[84] and has identified seven "sustainability factors": Disclosure, Adoption, Transparency, Self-Documentation, External Dependencies, Impact of Patents, and Technical Protection Measures.

Elements that have been highlighted as important considerations for format migration are the following:

Open Standards

The major concern highlighted from the survey centres on the choice of standards for the archiving of the video, audio, and other elements of the film work.

An analogy is often made with the computing industry, and appears to provide a valid lesson given the faster obsolescence of computing standards, systems, and software when compared with either the film or broadcast industries. Many important documents from the early days of computing are lost. This is not due to failure of the storage media, but is due to:

- The use of proprietary data formats, descriptions of which have never been published and the developing company may no longer exist.
- Obsolescence and disappearance of specific computing hardware and operating systems required to run the software application that created the data.
- Inability to run the software applications on modern hardware and systems.[85]

This analogy can be compared with the experiences of INA (see Chapter below) and other broadcast archives where much of the archive material is held on videotape[86].

To increase the survivability of digital archives, the formats in which the data elements are held should be both standardised and open.

---

[84] http://www.digitalpreservation.gov/formats/intro/intro.shtml
[85] Partial solutions exist via the use of software systems emulators. These are not always available and may not provide the full functionality of the target system required to successfully run the application.
[86] As an example, INA holds videotape archives covering most magnetic videotape recording formats, amounting to several hundred thousand hours' worth of content.

'Standardised' means that a full description of the data format, as well as instructions for decoding the format back to the original content should be unambiguously described.

'Open' means that the standard is available to current and future archivists and may be kept with the archive material if desired (for example, to be compliant with OAIS guidelines). It does not necessarily mean 'free'.

At a different level of abstraction, the structure of the archive should also be standardised and open allowing recovery at a different level if needed.

Awareness of the need to address preservation issues in standardisation is growing.

- Specific JPEG2000 profiles for long-term preservation of moving images became ISO standards[87] following the work in the EU Project EDCINE
- At the 96th MPEG meeting (21 – 25 March 2011), agreement was reached on the creation of a specific MPEG Ad Hoc Group on Multimedia Preservation. The first meeting of this group, which will define use cases, identify requirements, and recommend future MPEG activities in multimedia preservation will begin in July 2011[88].
- Several standards currently being discussed have potential to be interesting from the preservation standpoint, as IMF- Interoperable Master Format, AXF- Archive eXchange Format, and the previously mentioned Image Interchange Framework (IIF) project.

Unencrypted Data Formats

In order for archives to preserve content, content must be accessible. Content must be able to be manipulated:

- To ensure preservation, content must be able to be moved from one support to another, and/or be duplicated, without requiring clearance from the rights holders.
- The integrity of content must be verifiable. If content is delivered encrypted and locked to specific devices, it can be stored, but not preserved.
- Content may need to be accessible, depending on the legal obligations of the archival institution.

Encrypted content without the archival institution possessing the decryption credentials ('key') renders any preservation activities useless. An institution may faithfully preserve the encrypted material over generations, but will be unable to execute data and format migrations to avoid material and format obsolescence.

If the organisation charged with providing the key suffers an unrecoverable disaster (physical, financial, or other), or the rights holders become untraceable[89], the key can no longer be generated (or recovered) and the content may be considered lost.[90]

---

[87] "ISO/IEC 15444-1:2004/Amd 2:2009"; they can be purchased as a document here: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=52174
[88] Moving Pictures Experts Group, http://mpeg.chiariglione.org/meetings/geneva11/geneva_ahg.htm
[89] A significant collection of abandoned film stock dating from the silent movie era was discovered in Dawson City (see "Rescued from the Permafrost: The Dawson Collection of Motion Pictures", Archivaria 8, Association of Canadian Archivists, Summer 1979). If the discovery had consisted of encrypted DCP discs rather than 35mm film reels, there would have been no story.
[90] This is assuming the encryption system to be robust and not susceptible to future brute force attacks or other indirect methods usually associated with content piracy, which could pose legal problems for any archival institution choosing this course of action.

For these reasons, it is strongly recommended that in the digital age, archives continue their relation of trust with rights holders' that has developed over the past century, and that content is held unencrypted in archival institutions. Access to content in the archive should be regulated by a different mechanism.

Maintaining Full Information Content with Lossless Data Compression

There are several definitions of video and audio coding for compression in use. For clarity, the following definitions are used in this document:

- Lossless Compression: A class of data compression algorithms that allow the exact original data to be reconstructed from the compressed data[91]. For video, lossless data compression usually achieves a maximum compression factor of about 2.
- Mathematically Lossless Compression: A synonym for Lossless Compression.
- Lossy Compression: A class of data compression algorithms that compress data by discarding information the data represents. The reconstructed data is an approximation of the original data[92]. Compression factors may be very high, with a subsequent reduction in image and sound quality.
- Visually Lossless Compression: This is a synonym for Lossy Compression for images where the amount of approximation in the reconstructed data is assumed to be invisible to a viewer when observing the image the data represents. This is a very subjective measure that also depends largely on the available displays, i.e. the loss that is not visible today might be very much visible in the future.
- Perceptually Lossless Compression: The general case of Visually Lossless Compression that may be applied to other forms of media ultimately interpreted by the human senses (audio, for example).

Applying lossy compression to video and audio files delivers the main benefits of reduced storage requirements and easier streaming over bandwidth constrained communication links. The economic benefits of these two applications have driven research in the compression field for over half a century[93].

However, all lossy compression schemes irrevocably modify the original. Cascading, or subsequent lossy reprocessing of images and sound processed in this way can have deleterious effects on the image and sound quality.

As the future use of content contained within archives is unknown and the archive has a responsibility to preserve the heritage represented by the content for future generations, the working assumption is that digitisation for preservation attempts to capture the maximum information that the original medium is able to carry and then preserves this using some form of lossless data compression, or stores the original files with no compression at all.

---

[91] Examples are JPEG 2000 in lossless mode for images, and most computer data compression algorithms such as the Zip file format. Computer data compression algorithms may also be applied to uncompressed image files with differing degrees of effectiveness.

[92] Most multimedia compression algorithms fall into this category. Current examples are the MPEG-2, MPEG-4 and JPEG 2000 for video, as well as mp3 for audio.

[93] The introduction of interlace television is one of the earliest lossy compression schemes. Transmitting alternate lines only of a complete image maintained a subjectively acceptable picture display rate and resulted in a reduction in bandwidth by a factor of 2, consistent with equipment capabilities at the launch of modern television services.

Simplification of Coding and Compression Schemes for Archiving

The OAIS reference model for an open archival information system seeks to ensure that sufficient data is preserved to allow the archive to function over long time periods.

This includes maintaining information necessary for understanding (the representation information) and for the migration of that data (preservation description information).

One model of operation for digital archives is to hold the source content at maximum quality levels (full resolution, lossless compression, complete audio).

Concern has been expressed in some of the interviews associated with the study over the complexity of modern image and audio compression algorithms and the ability to respect the OAIS requirements for preservation and migration of data.

Due to limited experience in the field of long-term digital preservation, neither the FHIs nor the industry (in this case the US studios, as no activity can be reported in Europe on the subject) have yet opted for one specific file format for long-term preservation. As mentioned earlier, file formats considered for long-term preservation include JPEG 2000, DPX and potentially new upcoming standards such as OpenEXR and IMF.

JPEG 2000 is accepted by the film community for lossy compression (it is the basis of the D-Cinema standard), and by extension may automatically become the default mechanism for lossless compression in cinema archives because it a master file format based on JPEG 2000 can easily produce other delivery formats for both theatrical and video distribution. That's the rationale behind the choice of JPEG 2000 within the EU project EDCINE and within the IMF standard, largely supported by the studios.

Another concern expressed during the preparation of this study relates to costs for the decompression process, which should be minimised in order to reduce both investment (in computer equipment used for software decompression) and energy consumption for running the equipment and providing air-conditioning.

In summary, an archive file format should favour simplicity of file format (in terms of the ability to be repaired if lightly corrupted) and simplicity of algorithm (in terms of energy consumed per encode/decode operation) rather than absolute compression efficiency, whilst retaining the features necessary for the packaging of different components (video, audio, metadata, etc.).

Management of Audio Soundtracks (including proprietary formats)

The management of audio in the digital age should follow similar principles as video, and use open and standardised formats for archival.

The DCI format specifies uncompressed encoding for audio soundtracks. A similar policy is adopted for archives and should be regularly implemented.

The remaining issue concerns film elements that contain proprietary digital encoding of multi-channel audio and that obviously need to be decoded in the digitisation phase.

Examples of these include:
- Dolby Digital where the digital information is encoded optically on 35mm film between the sprocket holes.
- Sony Dynamic Digital Sound which is encoded optically on 35mm film outside the sprocket holes.
- DTS audio that is stored externally to the film, for example on a CD-ROM, and that is time synchronised to the film by the use of a 24-bit proprietary time code that is encoded optically onto the film.

An approach that is in line with the OAIS model would be to decode the proprietary audio tracks at the time of digitisation of the film and to preserve the separate tracks in uncompressed (or compressed using lossless compression) format in the digital archive.

A serious concern is that these formats and the equipment to decode them will only survive as long as analogue film technology survives, when this will come to an end, reading and decoding these proprietary systems will become complex and

Summary

- A systems approach is recommended for the long term preservation of digital data.
- Harmonised consultation of catalogues and access would be benefits of a standardised approach to archive digitisation, once any rights issues are resolved.
- Long term digital data preservation must plan ahead to manage format and media migrations. Experience shows these to occur with a 5 year cycle.
- The decline in the photochemical film industry will continue. Photochemical media migration will cease to be an option for archive renewal and exploitation.
- Return to film as a mechanism for managing archives and resolving current issues with encrypted digital material will not be an option.
- For increased survivability digital material held in archives should not be encrypted. If other concerns mandate encryption, the archive should hold both the decryption key, the digital material, and should possess all the legal rights required for the preservation of this material (including format migration).
- To ensure survivability, archives and material held in archives, should be based as much as possible on open standards.
- The complexity of coding and compression schemes used for long term data preservation should be minimised.

costly. This is another reason why digitisation of the European cinema heritage cannot be postponed for long.

3.2.3.4 Technologies and Strategies Today

From responses to the questionnaire and individual interviews, levels of preparedness for the long-term preservation of films in digital format vary widely. Regardless of this, there are three common themes that recur throughout the responses. These are:

- Workflow, including metadata management.
- Ingest formats and ingest policy.
- Digital storage technology.

Although film is generally considered to be the archival support of choice due to its stability and longevity when compared with digital technologies, there is an acknowledgement that the transition to digital distribution and projection will eventually render film based material inaccessible. Digitisation is seen as an unavoidable necessity if European Film Heritage is not to go 'dark' in the face of digital projection.

3.2.3.5 Workflow

Digital cinema is at a very early stage in its development. Although there are emerging standards for distribution and projection, the same cannot yet be said for other elements of the production workflow, in particular relating to:

- *Integrated tool chain development*. Many replies to the questionnaire highlighted this issue as being one of the main technological obstacles to putting in place a digital archive.
- *Workflow methodologies.* Because there is no well-defined tool chain with stable interfaces, it is difficult to define a consistent methodology for managing the workflow from content reception through metadata creation to inclusion in a digital archive.
- *Consistent metadata descriptions.* The amount and type of metadata created to accompany ingested content varies across the Member States, depending on the level of preparedness for the transition to digital as well as on budget constraints.

3.2.3.6 Ingest Policy and Ingest Formats

From institutions that responded to the questionnaire, there is concern about the definition of policies the formats and supports that can or should be accepted for ingest into an archive. The uncertainties surrounding tool chain stability and workflow expressed in the previous section inhibit the definition of ingest policies by FHIs for born-digital work. This may be summarised by one response: "…if we are not ready to archive, then we are not ready to impose standards [for ingest]".

Most organisations expect to receive works in at least DCP[94] or DCDM[95] formats for born-digital works, and for these to be either unencrypted or to be delivered with the appropriate decryption keys. However, without adequate policies, possibly reinforced by legal deposit legislation, delivery in these formats is not always guaranteed and FHIs are likely to receive basically any image and video format possibly in use, particularly if they accept DSM (Digital Source Masters) in deposit. Obviously, this does not include internal digitisation from either analogue or digital videotape standards, where in some instances material only exists on videotape.

Digital preservation requires a systems approach and its strategies' success relies on the definition and implementation of strict procedures, for example regarding file formats to be used and metadata. Any user of digital content or documents (emails, text, video or musical files) is very aware of the fact that preserving and retrieving a file depends largely on where and how it is created, named,

---

[94] DCP: The format for Digital Cinema distribution, standardised by DCI and SMPTE. It is, in effect, a 'Digital Print'.
[95] DCDM: The Digital Cinema Distribution Master format specified by DCI and SMPTE. The DCDM provides uncompressed master elements enabling creation of a DCP.

described and stored, and that this is easier, faster and safer if it is done as early as possible in the history of the document.

Similar principles obviously apply to the preservation of cinema digital content, and in fact there is a growing attention to the issue of metadata creation and gathering all along the lifecycle of a production, from image and sound capture to post-production and distribution, up to the ingest into the archive.

Unfortunately, the nature itself of the cinema production chain and of the underlying business models have always been focused on a 'one film at a time' approach, where a post-house or a production company are focused on one or few titles at the time, for a relatively short period of time, which are then discarded as soon as finished to make place for the next. Fast technical developments also mean that workflows (and equipment, and file formats, etc.) change very rapidly. All of this leads to the fact that in the cinema production phase, any type of standardisation is usually the very last of the concerns. This has to change if cinema works are to be preserved effectively and efficiently.

Significant efforts for the standardisation of metadata throughout the production process are undergoing in the US in the cinema industry and in collaboration with the institutions like the Library of Congress[96]. Unfortunately no similar projects have been undertaken in Europe.

As many respondents highlighted, their efforts in preserving digitally produced cinema works depend to a large extent on how early in the production chain and how consistently rules and procedures aimed at long-term preservation are introduced, mostly regarding metadata, technical metadata and formats.

3.2.3.7 Digital Storage Support Technologies

Digital storage technologies used for archival purposes tend to be limited and to fall into three categories: optical disc technologies, hard disc, and magnetic tape.

Optical support technology. Optical disc technology for the archiving of digital data has been available since the advent of the CD-R allowed data recording to optical media without the need for stamped discs. Today, dual layer DVDs allow a recording capacity of around 9.5GB and dual layer Blu-ray discs have a storage capacity approaching 50GB. Recordable DVDs have found ubiquitous use in both professional[97] and consumer environments. However, the longevity of data stored on these supports has been called into question[98]. Research work is continuing to examine possible new optical supports (including polyester film and long life optical discs) with data longevity approaching that of analogue film whilst recording data[99].
The storage capacity of optical discs has traditionally lagged behind that of hard discs and magnetic tape and it is far too low to archive cinema content at high resolution in an online or near-online archive.

---

[96] See for example: http://www.oscars.org/science-technology/council/projects/metadata-symposium/index.html

[97] For example, the recording of radio and television programmes under "Legal Deposit" schemes such as is operated by INA.

[98] "Longévité de l'Information Numérique", J.-C. Hourcade, F. Laloë, E. Spitz, Académie des Technologies, 2010. ISBN 978-2-7598-0509-9.

[99] "Naissance de la Société Essilex", MOS Magazine 268, http://www.mosarca.com/2011/MOSMAGAZINE268/indexmos268.html

Hard disc technology. The capacity of hard disc storage has continued to increase and outpace optical disc technology. Disc drives are closed systems, and as disc capacity increases, so does the impact of a device failure. This leads to the introduction of different strategies to mitigate errors[100].

Magnetic Tape Technology: All respondents that specified the use of magnetic tape as a storage medium indicated the use of the LTO[101] (Linear Tape Open) format. Current generation tapes (LTO5) have a native storage capacity of 1.5TB per cartridge, with a planned roadmap up to 12.8TB native capacity per cartridge as shown in the Ultrium roadmap below[102].

The difficulties encountered with the introduction of new technologies described above and the wide range of preparedness for the transition to digital indicated in responses to the questionnaire indicates that benefit could be obtained from a common approach at a European level to a common problem for FHIs at a

ULTRIUM LTO — Eight-Generation Roadmap

	Generation 1	Generation 2	Generation 3	Generation 4	Generation 5	Generation 6	Generation 7	Generation 8
			WORM	WORM	WORM	WORM	WORM	WORM
				Encryption	Encryption	Encryption	Encryption	Encryption
					Partitioning	Partitioning	Partitioning	Partitioning
Compressed Capacity	200 GB	400 GB	800 GB	1.6 TB	3 TB	8 TB	16 TB	32 TB
Native Capacity	100 GB	200 GB	400 GB	800 GB	1.5 TB	3.2 TB	6.4 TB	12.8 TB
Compressed Data Rate	up to 40 MB/s	up to 80 MB/s	up to 160 MB/s	up to 240 MB/s	up to 280 MB/s	up to 525 MB/s	up to 788 MB/s	up to 1180 MB/s
Native Data Rate	up to 20 MB/s	up to 40 MB/s	up to 80 MB/s	up to 120 MB/s	up to 140 MB/s	up to 210 MB/s	up to 315 MB/s	up to 472 MB/s

Note: Compressed capacities for generations 1-5 assume 2:1 compression. Compressed capacities for generations 6-8 assume 2.5:1 compression (achieved with larger compression history buffer).
Source: The LTO Program. The LTO Ultrium roadmap is subject to change without notice and represents goals and objectives only.
Linear Tape-Open, LTO, the LTO logo, Ultrium, and the Ultrium logo are registered trademarks of HP, IBM and Quantum in the US and other countries.

Member State level. The sharing of expertise and development common, interoperable solutions would help increase the level of skills on a European basis. The transition to digital needs a systems approach by FHIs, and whereas a single FHI may not have the resources to successfully address the issues, the pooling of resources should allow substantial progress. The adoption of a defined system framework, such as the OAIS model should allow all parties to discuss using a common vocabulary and definitions.

---

[100] A Fresh Look at the Reliability of Long-term Digital Storage, M. Baker et al., EuroSys '06, April 18-21, 2006, Leuven, Belgium.
[101] Ultrium LTO Linear Tape Open format, http://www.lto-technology.com
[102] Source: Ultrium LTO technology roadmap, http://www.lto-technology.com/roadmap.html

Summary

- Development of systems and strategies for the long term preservation of films in digital supports is at an early stage, with a wide range of readiness amongst FHIs who responded to the project questionnaire.
- Adoption of a systems approach with exchange of best practices at a European level can aid the transition.
- The lack of a stable and integrated tool chain for ingesting and managing digital content is slowing progress.
- FHIs have difficulty defining ingest policies and acceptable formats due to a lack of visibility of the evolution and development of industry standard formats, tool chains and workflows.

3.2.4   Passive Archival Systems

Recently, including during the course of this study, different solutions for the passive archival of born-digital material have either been published or have been proposed. These systems represent a "passive archive" in the sense that they are analogous to current film archives:

- Content is written to long life media.
- The media is stored in a physical archive, with limited access.

3.2.4.1 Digital Optical Tape Systems

Research to use a stable and inert optical support onto which to "write" data has been underway for over a decade. Supports of choice have included different materials, from polyester to metal alloy and film stock. A new system[103] was made public at IBC[104], and the description below illustrates the advantages and disadvantages of this type of approach.

The technology is based on a tape media having optical phase change characteristics, allowing data to be recorded in a form which is optically readable, and which therefore can be read with suitable optical imaging equipment. A second benefit is the possibility to include instructions for reading the data on the tape in human readable form (albeit at a microscopic scale).

If successful, the technology resolves two of the main issues with current large-scale archive systems:

- Media migration is extended to a century-long timeframe from once every 5 or so years as is required with current tape-based systems.
- Storage is claimed to consume less energy than for today's film archives, and will certainly consume less energy that on-line or near-line storage systems.

---

[103] The DOTS (Digital Optical Tape System) from Group 47 LLC based on earlier work by the Eastman Kodak Company. Information is drawn mainly from the Technology Overview document available on the Group 47 website http://www.group47.com
[104] International Broadcasting Convention 2011, 8 - 13 September, Amsterdam

- As the system appears to present a transparent data channel, data may be written and retrieved in any format, allowing for transparent accommodation of any future evolution of digital cinema file formats and technologies.

With respect to existing film based archives:

- The impact to existing policies for handling physical collection elements should be minor; multi-volume storage of individual works is likely still to be necessary.

In the context of access to European Film Heritage collections, the following issues with all proposed Optical Tape / Data on Film solutions remain:

- Storage is off-line, and so consultation of original material has a definite cost and time delay.
- Details of the writing process and required equipment are usually not publicly available.
- Although details of reading the data on the tape are written on the tape itself, for the moment, this system would appear to be single source, i.e. supported by only one vendor. It is worth recalling the experience of the CNES (see later Section *Archiving Space Exploration Data*), which invested in the CREO optical tape system for long-term archival, only to be obliged to migrate to a different support as a matter of urgency.

3.2.4.2   Long-life Digital Optical Discs

A second approach, which is proposed by several groups, is the long-term archival of data using the CD/DVD optical disc format. Whilst not offering the same data capacity per storage element as any Optical Tape system, the optical media is read-compatible with DVD readers.

Such a solution offers the similar advantages and disadvantages as systems similar to DOTS:

- A transparent data channel allows for evolution of born-digital cinema formats.
- The media migration cycle is extended to be comparable with that of current photochemical archival film stock.
- Media migration is lossless.
- The composition of the physical media is the differentiator from conventional optical media.

Differences with the DOTS system are:

- Each disc holds less data than either a DOTS or LTO tape. Therefore an archived film element will be split across many more physical elements (hundreds of DVDs, and dozens of Blu-ray discs are needed to store a feature film at 4K resolution).
- Readability depends on the continued existence of optical disc readers which are able to recover data from optical discs using the DVD-ROM format standard.

3.2.4.3   The CNC[105] Proposal for Archival of Digital Content on Film[106]

The CNC recently proposed a third option for the management of born-digital material. The proposal is to migrate born-digital material back to analogue photochemical film stock for long-term storage.

---

[105] Centre National du Cinéma et le l'image anim ée.
[106] "Collecter et Conserver Les Films Du Dépôt Légal Fournis sur Support Numérique", René Broca and Etienne Traisnel, June 2011.

The CNC proposal insists on the clear separation between the activities of consultation and conservation, and recommends a return from digital to photochemical film stock for long-term archival purposes as an intermediate solution until a better solution appears.

In this scenario, a modification is proposed to the legal deposit scheme in France, requiring the deposition of two copies of the work; one in digital format, which will be used for consultation; and one in analogue format on photochemical film stock which will be used for long-term preservation.

Seen from a "born-digital" perspective, this approach differs quite dramatically from the previous two systems:

- There is no longer a transparent digital channel. The born-digital work is not preserved as created, thus the "Create digital – archive digital" principle is not adhered to:

    o Differences and losses in the image quality will be encountered by the process of conversion to analogue and subsequent re-digitisation, making the assumption that the delivered film copy is of a quality equivalent to the born-digital work.

    o Audio, as recognised in the report, is problematic. Many formats are proprietary, which presents problems for long-term preservation as remarked earlier. In addition, the move by the industry away from any physical support frees audio formats from any requirement to be compatible with a film-based support. In the case of advanced formats, the transfer to black and white film (one of the options in the CNC report) may not adequately preserve new and complex audio formats[107]. Digital storage of the audio component (the second option) relies on decoding equipment continuing to be available. Any associated difficulties (legal or technical) in the disassembly of digital works into their component elements and subsequent re-assembly potentially many years into the future must also be overcome.

- Parallel conservation/consultation chains must be maintained.

3.2.4.4 Conclusion

In conclusion, passive archival systems for long-term data storage have been constantly under development, but no clear marketable option has come to the market, beyond the traditional ones (hard disks, data tape and solid state memory). If new media and systems will become available in the future, these might (or might not) meet the requirements for long-term preservation of European Digital Film Heritage.

Proprietary technology from single-source vendors have been shown to present a risk for long-term preservation of data. There at present, a gap between the film industry transitioning to digital and these systems become widely available. Although passive archival allows FHIs to continue to manage digital content with essentially the same

---

[107] For example, see "Lucasfilm selects Auro-3D 11.1 cinema audio format", Broadcast Engineering Audio Technology Update 23rd October 2011, or "Auro 3D Octopus Codec, Principles behind a revolutionary codec", from "http://auro-3d.com/professional-technical-docs/".

procedures and policies as today, it does not facilitate wider, de-localised consultation or access to the full quality works.

Passive archival will not solve the format obsolescence problem. In other words it will not eliminate completely the need to migrate collections, it will only increase the time in-between migrations. Ultimately, these solutions will be advantageous only if the cost and the complexity of their inevitable migration is lower than those of the more traditional media.

The "going-back-to film" solution was already discussed in an earlier part of this Study (see Section *Media and Format Migrations*), and concerns can be summarised as follows:

- The rationale behind the model is the assumption that digital preservation can be 'reduced' to discovering a medium having a longer life expectancy; this approach seriously underestimates format migration issues and does not take sufficiently into consideration the systems approach required by digital preservation. An inherent contradiction of the solution is that it is designed to address the transition from analogue to digital technologies by remaining with the technology that is fading out; as a solution, it 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.
- Many archivists do not consider that digital images being written onto film represent a faithful representation of the original work.
- At €25K to €100K per feature film, the going back to film solution appears to be 20 to 80 times more expensive than digital preservation;
- Costs might be a serious concern for many countries, producers, particularly in the current situation of the cinema industry and the economy.
- Finally, the higher costs do not guarantee the success of the strategy in the long term, as this is inextricably bound to the fate of the analogue film industry;

3.2.5   The road ahead

3.2.5.1   A need for research?

Discussions held with interviewees as well as responses from the questionnaire have highlighted several areas for continued research. This section provides a summary of the topics and areas that could be considered for further research.

Archive stability and durability

Feedback received from contributors to the study has demonstrated the feasibility of construction and operation of digital online archives with the required capacity[108]. Nevertheless, and perhaps due to the backgrounds and history of the organisations involved, there have been several suggestions for research on the topic of archive and storage media stability.

Specific topics mentioned are:

---

[108] The systems specified and operated by the CNES and INA (see section 5).

- Archive design and architectures that should be able to survive a "power off" of a significant duration and successfully restart without compromise of stored data.
- Systems and architectures optimised to manage and preserve collections with characteristics specific to cinema content, that could be developed as open-source services offered to EU FHIs
- The development of stable digital formats and physical supports that are open and sustainable, having ideally the same shelf life as black and white film stock.
- Architecture of distributed archives, a study of the cost of operation and possible models for cost recovery associated with these archives. The feasibility of a European managed "Cloud" that could meet the combined storage and access requirements of different industry segments whilst providing economies of scale and best practices for management, operation, security and stability[109]. Elements of such a cloud infrastructure are being researched in other European projects. One such example is the ETICS[110] project which contributes to the objective "Network of the Future" in the FP7 Future Networks cluster. This can be viewed either as an alternative to the LOCKSS[111], or complementary, dependent on the number of individual copies of data that FHIs can afford to keep and manage, as well as the potential legal implications of keeping many copies stored in different locations across Europe.

Archive content security

There have been two driving factors behind the suggestions of research in this area:

FHIs have in their possession valuable, or potentially valuable, collections. Over the years, FHIs have developed physical security measures and procedures to protect their collections. The transition to digital represents a significant cultural shift for FHIs, and requires an interdisciplinary approach to security in an area where most FHIs will be seeking to build competence. Research into effective security methods for FHIs in the digital age is seen as one way to encourage best practices.

Concerns over the delivery of DCP format data without the decryption keys have been described earlier in this report. There is interest in exploring alternative mechanisms or formats that may be better adapted to online storage and archival purposes than the DCP.

Specific areas of research suggested are the following:

- Digital archive security other than content encryption. This may include all aspects of security related to the management and operation of a digital film archive.
- Content security in a 'cloud' based distributed architecture.

---

[109] The CNES STAF system (see Section 5) demonstrates the feasibility of managing data with widely varying formats, sources and applications within the same system.
[110] Economics and Technologies for Inter-Carrier Services (ETICS). Thanks to Richard Douville, Technical Project Manager, Alcatel-Lucent for providing background information. See https://www.ict-etics.eu/home.html .
[111] LOCKSS: "Lots Of Copies Keeps Stuff Safe". See "http://lockss.stanford.edu/lockss/Home".

Content search and access

There is already a significant amount of activity in this field at a European level that has already been mentioned earlier in this report. Reinforcing this, the following suggestions were received:

- Interoperability of indexing, referencing, and search systems including a roadmap for implementation (continuing and extending the work beyond CASPAR).

- Continued research into search mechanisms for online film content. Topics such as new search metaphors, automated film indexing or salient feature extraction should be included.

Content digitisation

Feedback indicates two areas where research could be undertaken to either speed the process or to reduce the overall economic burden of digitising European film heritage:

- Improved quality of economic digitisation processes and systems. Increasing the quality of unattended restoration (either basic and/or advanced) whilst avoiding the introduction of additional degradations to the scanned images. Improved automated detection and signalling of errors and defects is part of this process.
- A repeated comment received is that film scanners or telecine equipment are not well adapted to aged and degraded film supports. Current equipment is reported to only handle new film stock well. As film as a distribution medium becomes obsolete, most film stock will age in archives and the value chain for investment in film scanner development will collapse. There is a risk of a "film black hole" if degraded film stock cannot be adequately read at the end of life of film as a support.

3.2.5.2 New structures for new skills?

The transition to digital brings two challenges to existing FHIs. The first is the management of existing film based archives as film as a medium for content creation and distribution disappears. The second challenge is the need to develop new competences in the IT field.

There are clear advantages to managing the transition to digital in a coordinated manner at the European level.

As film disappears, the ecosystem around photochemical archives will shrink. This major change will impact the current skill base, which will ultimately all but disappear.

At the same time, the decreasing prominence of film as a format for content creation and distribution will result in a reduction in the level of equipment and processes available for the handling of film.

Cooperation between FHIs at a European level will become a necessity, perhaps driving a reduction in the number of 'centres of excellence' in order to maintain the ability to handle and preserve remaining film based archives.

The transition to digital could be managed on a case by case basis by each FHI individually. However, such an approach brings with it the risk of lack of compatibility across European FHI systems if common standards are not agreed upon. Individual initiatives limit the opportunities for wider access and geographical redundancy of storage that could be gained by a distributed approach.

A possible perspective for an innovative approach, although definitely something to be considered in a long-term timeframe, would be the creation of a European based structured and managed "Cloud" allowing decentralised, secure storage for digital works with a common catalogue and access via Europeana.

Acquisition of the required IT skill base could be accelerated by shared operation of such a distributed facility across different industry segments, allowing natural cross-fertilisation of skills from industry segments established in the field (such as the earth observation industry) to the film heritage segment.

From an ICT perspective, each Member State would need to ensure adequate training in these skills. Cross-industry comparisons show that manpower requirements are relatively small, but require relatively high skill levels due to the mix of established and innovative technologies that would be deployed were the proposals in this report to be implemented. Issues of attraction and retention of qualified staff also play a role in the costs of acquiring the appropriate skills.

Estimating the cost of developing these skills is difficult, not least due to the different conditions in each Member State.

3.2.6   A cost / benefit analysis

3.2.6.1   Basic Hypotheses

This section covers some basic hypotheses relating to the format and types of data stored in a digital archive. The assumptions in this section impact the scaling and potential use of the digital archives for which cost estimations are later made.

It is important to understand that the aim of this exercise is to define costs in terms of 'magnitude' based upon reliable figures and facts, so that these considerations can be used to design policies and strategies, more than come to a 'final precise figure', that is simply impossible because of the number of variables that affect not only the overall picture, but the highly differentiated situations in all 27 MS.

3.2.6.2   Archive Capacity

One potential use for a digital archive is as a replacement for film as an archive medium, or at least holding full resolution digital copies of the source film, as opposed to restricting the digital archive to low resolution copies. Adopting such a hypothesis results in the following assumptions and dimensioning for archive planning:

- Feature films are held in digital form at full resolution[112]. This resolution corresponds to that expected of distribution film print stock, and is also the basis behind the definition of this format for use by DCI. Original camera negative may have higher resolution.
- The scaling factor for films assumed to be held at 2K is 1/5.33 (This is the scaling factor between DCI 4K and 2K formats, taking into hypothesis bit depth as explained in the footnote).
- Lossless compression is assumed (reduction by a factor of 2). Lossless compression preserves all information, and so a reduction by a factor of 2 is a statistical measure, depending on the type of material and compression algorithm in use.
- Black and white films are assumed to have the same capacity requirements as colour. This is for simplicity of calculation and management and represents a 'worst case'. In reality one would expect lossless compression of black and white film to yield a greater compression ratio based on the above conditions.
- Incremental audio capacity is negligible (< 1.0e-3). The majority of the data capacity is allocated to the image component of the work. The factor in brackets represents the proportion of data capacity of the image data that is required for supporting audio formats.
- Full (4K) resolution stereoscopic 3D is not considered.

Considering the above, the data capacity per hour of digital content is:

- 2.09 TB / hour for 4K material without redundancy.
- 0.39 TB / hour for 2K material without redundancy.

3.2.6.3 Archive Architecture

Archives are assumed to be fully redundant and geographically dispersed. The result is assumed to be the doubling of investment, infrastructure, and operating costs. This is a worst case figure.

Shared but geographically dispersed archives can consolidate infrastructure cost vs. increased capacity. A more optimistic cost estimate would only include the incremental capacity cost for the second archive.

Technology obsolescence is assumed every 5 years[113].

A mix of tape based main storage with disc based front-end cache is considered. This appears to be the architecture of choice for combining data capacity, long-term storage and reduced energy consumption[114].

---

[112] The DCI 4K format taken here is 4096 pixels per line x 2160 lines per frame x 24 frames per second x 16 bits per pixel per colour component. Whereas the DCI specification limits the active bit depth to 12 bits, this limitation is not applied in the following calculations as it is not felt appropriate to introduce such a limitation for the scanning of high quality archive content which is expected to serve as the archive reference source for the generation of subsequent copies (not included in the calculations).

[113] An estimated interval of 5 years between major technology migration, either hardware or software, is based on the operational experience of organisations interviewed for this report.

[114] A second option of a completely disc based archive was considered but not pursued due to reasons of energy consumption, feedback from interviews, and concerns over reliability. See "Failure Trends in a Large Disk Drive Population", E. Pinheiro, W.-D. Weber, L. A. Barroso, Proceedings of the 5th USENIX Conference on File and Storage Technologies (FAST '07), February 2007.

Tape storage is assumed to be based on the LTO (Linear Tape Open) format and the discussion below assumes the published roadmap for capacity increase will be adhered to.

LTO sustained data rate is assumed to be ¼ of the peak data rate. A 1PB refresh (read from old cartridge – write to a new cartridge) by technology LTO technology generation is shown below:

LTO Gen	Peak Data Txfr MB/s	Sustained (Estimate = Peak/4)	Cartridge capacity (GB)	Txfr time per cartridge (hours)	Txfr time per TB (hours)	Txfr time per serial PB (days)
3	80	20	400	6	14	579
4	120	30	800	7	9	386
5	140	35	1500	12	8	331
6	210	52,5	3200	17	5	220
7	315	78,75	6400	23	4	147

The term "serial PB" is used to refer to the cumulative reading or writing of 1PB of data using one cartridge reader and one cartridge writer. The time for media exchange is assumed to be negligible.

For a tape based archive, the above table allows a minimum dimensioning in terms of tape drives for an archive to simply refresh itself without ingest or access. It also indicates the order of magnitude access time for content access.

3.2.6.4 Archive Dimensioning

From an analysis of existing systems, the following conclusions may be drawn:

Major cost items scale linearly with archive size: Robotic cassette system, Hierarchical Storage Management file system management system.

Labour costs are variable. Factors that drive labour costs are the following:

- Technical support availability.
- Documentalist support for classifying and adding metadata to pre-existing or newly ingested content.

For the purposes of estimating manpower costs related to archive operation, only technical support functions are taken into account in the proceeding analysis. The level of documentalist support is dependent upon the commercial model under which the archive operates. This leads to a wide variability that is not considered here.

A preliminary cost assessment is based on the following assumptions:

- A main content archive is assumed (transition from film to digital for the master copy).
- Low resolution browse access is not addressed in a first step. However incremental costing for a disk based browse archive based on DVD resolution

material can be given. A disc capacity of about 2.2TB per PB of main archive would be required to hold all the archive material.

- Main storage based on LTO7 tape technology.
- A single robot mechanism and HSM per archive site.
- Redundant sites either share technical staff or an offset redundancy scheme is supposed. No duplication of technical staff at redundant sites is assumed, and technical staff is assumed to be skilled.
- A major planned migration is required once every 5 years on average.

Based on the above hypotheses[115], a cost of storage is arrived at in the range of 0.14€ per GB per year and 0.25€ per GB per year for a fully redundant storage system with capacities of 40PB and 20PB respectively. Energy costs represent between 2% and 2.5% of the total.

Annual overall costs would be then €145K/PB, or a total of €5.8M for a 40PB archive. For a smaller archive of 20PB, these figures would be €250K/PB translating in a €5.0M budget for a 20PB archive.

3.2.6.5 Incremental Annual Capacity

Whilst it is difficult to estimate the growth rate in digital production, particularly for short films and documentaries, it is possible to reach an estimate for the number of feature films produced at a European level in the past. The table below shows an estimate for the amount of additional storage capacity required per year based on the estimation of 1100 feature films produced at a European level. The simplifying assumption is made that the average feature film duration is two hours.

Estimating the annual incremental capacity required for short films and documentaries presents more of a challenge; short film production is not tracked by all Member States, the length of a short film may vary between 6 minutes and one hour, and the resolution/source definition of the material is unknown. Based on figures available from the MEDIA programme[116], the estimated production of short films by those member States covered in the report is approximately 1400 for the period 2007 – 2008.

The table below gives an indication of incremental annual storage required to archive all of Europe's annual film output[117].

	Annual film production	DVD Quality	Blu-ray Quality	DCI DCP Quality	2K lossless Quality	4K lossless Quality
Feature Films	1100	10	47	236	858	4589
Short Films	1400	3	13	63	228	1217

---

[115] Based on cost projections for the middle of this decade. The sources of this information cannot be disclosed for reasons of confidentiality. Contributions have been made from both the Space and Broadcast Industries.

[116] "Short films production support institutions in Europe", covering Belgium, Bulgaria, Croatia, Denmark, Estonia, Finland , France, Germany, Greece, Italy, Ireland, Lithuania, Netherlands, Norway, Poland, Portugal, Romania and Switzerland, for 2007-2008.

[117] Imprecision in the source data makes this a very rough approximation based on assumptions of short film running length and source resolution.

Totals	2500	13	60	299	1086	5806

Terabytes of annual incremental storage required for annual feature and short film productions

At current rates, incremental new feature film content will require approximately 4.5PB of storage for digitisation at full 4K lossless quality, the equivalent of 35mm film storage. Short film production, if originated at 4K resolution will require an addition 1.2PB of storage capacity, less if originated in lower resolution formats

3.2.6.6 Extension to Europe

Data on the size and extent of collections in Film Heritage Institutions is not easy to obtain. The data used in this section are compiled from a number of sources[118]. Not all institutions have a policy of publishing the extent and composition of their collections, so the estimations used will contain some margin for error[119]. Information missing for Member States is compensated by linear extrapolation.

Nevertheless, the available information allows the presentation of the scale of the task facing Europe.

In the absence of more detailed information about the composition of collections, it has been necessary to estimate the proportion of material that falls in each category (feature film, documentary, short film, TV recording) and hence the amount of storage capacity likely to be required. Estimations have been biased towards the worst case (greatest storage capacity required):

- A feature film is assumed to have a length of greater than 90 minutes.
- Documentaries are assumed to have a duration of 60 minutes.
- Short films are assumed to have an average length of 48 minutes.
- Where the split between feature films and shorts in a collection is unknown, the split is assumed at 60% feature film, 40% short film.
- Television material is assumed to have DVD resolution.
- The split between 4K and 2K resolution is made in the ratio 1:2[120].

Based on the above, the total storage requirement for a direct digitisation (with only partial consolidation of duplicate catalogue elements between institutions) of Europe's Cinema Heritage can be estimated at slightly more than 1 Exabyte, or 1050 Petabytes.

Using the model previously described, the cost of storing this amount of data across Europe is projected at €147M. This figure is based on a model that implies some level of consolidation, with the creation of one archive system per MS with a capacity of 40PB. Cost per PB increases if a solution based on smaller archives systems is chosen. The implementation of 54 20PB archive systems across Europe would result in a cost per PB of €250K, or €263M per year for the preservation of the whole European cinema heritage after digitisation. These figures are shown in the table below.

---

[118] Sources include survey questionnaire results and information publicly available via the internet for film institutions in each Member State.

[119] Similar difficulties have been encountered in estimating the size of the EU public domain. See "The Size of the EU Public Domain", Rufus Pollock and Paul Stepan, Cambridge Working Papers in Economics, http://EconPapers.repec.org/RePEc:cam:camdae:1046

[120] Required storage capacity will depend not only on digitisation resolution but also on whether the material is colour or monochrome. This figure can only be an estimate. It is also one of the two parameters which most affect the outcome of a sensitivity analysis on the data, the other being the split between feature film and short films in collections.

Total storage capacity:	1050	PB	1050	PB
Archive system capacity:	40	PB	20	PB
Total number of archive systems:	27		54	
Archive systems per Member State:	1		2	
Fully redundant amortised storage cost per system:	140	K€/PB/yr	250	K€/PB/yr
Total annual cost of storage:	147	M€	263	M€

Whilst this figure may initially seem large, based on an archive installation of the type described above, the total infrastructure requirement is less than two fully redundant systems per Member State. (As a reminder, manpower costs are already included in the figures in Figure 4.)

Summary

- Digital storage technology is available which meets the needs of digitised FHIs archives.
- The transition to digital represents a major cultural shift for FHIs and requires mastering new skills in the IT domain.
- Areas for further research have been identified and include the development of durable digital storage formats, archive content security, content search and access, and specific aspects of digitisation.
- Cooperation at a European level to foster these skills and manage the disappearance of the film ecosystem would be advantageous.
- Based on estimations of European Film Heritage collections, fully digital storage with no consolidation of duplicated content would occupy around one Exabyte at an estimated cost of 147M€ per year for 40PB archive capacities and 263M€ per year for a 20PB archive capacities.

3.3 Digital Restoration

3.3.1 State of the Art

According to most of the stakeholders' views expressed in interviews or via the survey, digital restoration can be considered a 'mature field', with a handful of specialised software solutions to correct damage and flaws in image and sound that have been available and constantly updated for some time.

As a matter of fact, the research and development in these areas seems to have slowed down considerably in the past years, when compared to some 10-15 years ago. In the case of sound restoration, there seems to be hardly any development going on at all.

Further evidence of this is given by the fact that prices for software went significantly down in the past couple of years, probably due to a decreased investment in R&D.

Another key factor in a dramatic reduction of costs is the drop in hardware costs, with computing power and storage costs plummeting very fast.

In other words hardware and software costs are decreasing very fast, thus making digital restoration technologies so affordable that FHIs can finally consider getting equipped internally.

On the other hand, digital restoration is applied to the utmost extent in many specific restoration projects (as opposed to mass digitisation projects, where it is hardly ever used). This translates into high costs for digital restoration that are now due almost completely to labour costs, as image and sound restoration at high quality (i.e. the kind of quality required for cinema re-distribution or some Blu-Ray mastering) cannot be fully automated, but a significant amount of supervision and manual work is always needed.

Generally speaking, most experts agree that manual intervention will always be necessary, as software tools will never acquire the necessary intelligence and judgement to discern flaws and damage from image and sound features (an all-time favourite example is that of a white blotch vs. a soccer ball flying across the frame). Fully automatic or semi-automatic restoration is applied only to low-budget projects, either for only access or for low budget DVD productions. With HD masters being increasingly required by broadcasters, quality requirements are rising, and consequently more manual intervention is required.

There is also a large consensus about the fact that image and sound restoration is a much bigger factor in important restoration projects than scanning costs.

A remark that has been mentioned by many is that scanning technology should evolve further to make it possible to scan materials of as early a generation as possible, for example original nitrate negatives in bad physical condition rather than newly produced preservation element, that might be in pristine physical condition, but that inevitably suffer from a lower image quality than the originals.

Over the past 2-3 years, most scanning equipment manufacturers showed a growing interest in the archival market and introduced technical features to meet its needs. This should be seen in relation to another serious concern shared by many experts.

Concerns have been voiced by many that R&D in the domain of scanning equipment (for image, and even more for sound) is going to plummet as soon as image capture in cinema productions goes completely digital. It is in fact true that most scanners currently used for restoration are modified versions of high-quality scanners developed to serve the modern cinema productions when they 'shoot on film' and post-produce digitally. When the digital capture will become predominant, there will no real market for scanners except in the archival domain, a domain that, as we pointed out earlier, is a niche domain.

This translates into a serious risk that high quality scanning equipment might slowly fade out of the market, and that in the medium to long-term scanning will become extremely complex and costly (mostly because obsolete scanners will have to be maintained).

If this forecast is true, it means that digitisation projects should not be delayed if they want to take advantage of the continuous support of scanning equipment manufacturers.

In a way, an indirect clue that this tendency could be true is that scanning equipment manufacturers seem to be more interested in the archival market than they used to be. Although positive in theory, this development might have a very negative reason: the market for scanners is shrinking and manufacturers understand that FHIs are their only future clients; this could be a first sign of decline for another industry related to analogue film, and very bad news for FHIs.

3.3.2   The future of Digital Restoration

3.3.2.1   Research and cost reduction

Apart from the abovementioned remarks concerning scanning equipment, not many fields of research seem to be considered critical at the moment.

In theory, there are several issues that current software solutions cannot solve completely, at least in an automated or semi-automated way, but experts and stakeholders seem to think that these problems are not to be solved completely by research, in other words that technology and algorithms sort of reached the end of the route, and that improvements will come, but nothing dramatic is to be expected.

Cost reductions are more likely to be obtained in the realm of a natural trend to lower the costs of software once R&D costs are re-paid, together with the overall downward trajectory of equipment costs. As one laboratory executive told us during an interview: "4 years ago we paid our first [name of SW/HW solution] with 2.5TB storage €92K, in 2010 we purchased another at €22K, with 8TB storage this time".

With this tendency in mind, the only area where cost reduction can take place is labour costs, with outsourcing and de-localization playing a potential role. In this case opinions are quite different, with some players already using outsourcing to countries such as India and Singapore, while others claiming that the level of know-how of the operators demanded requires extremely skilled operators that are not to be found outside their premises.

Ultimately, it is very possible that the question will be answered simply by demand, depending if it goes towards fewer projects requiring extremely high quality, or towards quantity-oriented projects.

There are different opinions about the direction the market of restoration is going. On the one hand there seem to be more restoration projects, and some important digitisation projects involving scanning and some degree of restoration, all factors indicating a growth in the market.

On the other hand the number of laboratories and post-houses offering such services is in fact shrinking. Laboratories offering film to film services are steadily disappearing and/or the quality of their work is declining, and even laboratories and post-houses providing digital services to FHIs seem to be shrinking, a factor that could indicate a declining market.

A factor that is currently hard to assess is the impact of the growth of HD broadcasting. With the number of channels increasing (7,528 television channels and more than 700 on-demand platforms were counted in Europe in 2009[121]), and with the growth of HD offering, new masters with better image quality are required for films that were already scanned and digitised years ago; this trend seems to appear in some markets, but it also seems to be geared toward a high throughput and somehow lower budgets, particularly for European productions that still suffer from lower audience and market share.

Whatever the direction the market is taking, there seems to be consensus on the fact that costs should be decreasing in the coming years, because of the combined effect of reduced software and hardware costs, of an expected overcapacity in scanning time due to declining scanning services required by new productions, and of price models that will suit better the high throughput model required by mastering for TV as compared to new cinema releases.

---

[121] Figures from the European Audiovisual Observatory - www.obs.coe.int

Summary

- Digital restoration is a fairly mature technology
- With HW/SW costs decreasing dramatically, Digital restoration costs are driven my labour costs, as fully automated systems are not realistic
- HW/SW costs are so low that FHIs can get equipped internally, this is more likely to drive costs down than outsourcing and de-localizing
- Research is required in the scanning technology
- Digital capture reduces the need of scanners for modern productions, there is a risk that R&D in the sector stops

3.4 Access to Film Heritage

3.4.1 Digitising for Access

For Whom?

Most if not all FHIs provide some sort of digital access to their collections, and they all state they have some sort of digitisation program, even if it is on an 'on demand' base[122]. Among these programs of digitisation and/or access, some are of particular importance for their scope and size, as those undergoing or planned in the Netherlands, Norway, Spain, France, Finland, UK, and others. In conclusion, there is an important amount of digitisation going on in Europe. This means that the question is not so much "why FHIs do not digitise", but rather why more of what they digitise is not made publicly available.

If we take the whole 'FHIs system' in consideration, all channels are used to provide access, from online to DVD to DCP. Obviously, the size of collections that is accessible, particularly as a percentage of the collections to be potentially accessed is extremely low.

Digital access is performed alongside the traditional 'on film' access that most FHIs provide: projections in their theatres, loan to other institutions and theatres, viewing on site for researchers, etc. On-film access remains important in the FHIs activities, although access on film decreased significantly over the past couple of decades, and it is expected to be limited to FHIs theatres only in the future.

Similarly to preservation, where digital preservation *adds* to analogue preservation and does not *replace* it, it is important to highlight that for all FHIs digital access goes alongside to other traditional forms of access and does not replace them to any significant extent as in most cases they make up new services and respond to new users.

According to the results of the surveys, almost all FHIs provide most digital access services to two categories of users: researchers and scholars on one hand and commercial users (mostly broadcasters) on the other, with the general public being largely served by theatrical projections or by DVD distribution (for the few FHIs that have a regular DVD distribution activity).

In both cases digital access follows a model that was already present in the 'analogue years', with researchers seeking access to a list of works for their studies, and broadcasters searching materials to re-broadcast or to re-use within new productions as documentaries.

Digital access for researchers means onsite viewing (with DVDs being seldom produced for the few rare public domain works), and in the case of broadcasters this usually takes place after agreement of the rights-holders and via some form of digital file or DVD.

---

[122] The study received input (by interviews or replies to the Survey) from FHIs based in 17MS. In 88% of the cases a digitisation activity of different extent and scope, was reported.

In some cases, more structured ways of accessing the collections on-site are possible, for example with workstations and servers from which digitised content can be browsed and accessed on the FHIs' premises. A leading example in this field is the 'BFI Mediatheque'[123] which, as all other examples, is limited to on-site viewing, but offers an impressive catalogue.

'Out-of-premises', remote access is generally limited to loans (provided that rights are cleared) and eventually to distribution of DVDs produced directly by the FHIs.

The examples of online access are so limited in scope and in size that they hardly make up significant examples and case studies. Leading examples include activities such as in Norway[124] or the Netherlands[125] that make available to the public most, if not all, of the national production.

These few examples show how rich the offer from FHIs can be once their vaults are unlocked by giving them the resources to digitise and the possibility to provide access.

As we pointed out earlier, the real question is why FHIs do not make their digitised collections available to a wider public, and why digital access is basically limited to the industry and to onsite researchers.

To this question, the almost unanimous answer from the FHIs is that besides limited funding for digitisation, the other key limiting factor in providing wider access to their collections is 'copyright'. Under the category 'copyright' many issues are grouped, which can be brought back to the complexity not only to identify the right-holders for works that in some cases date from 100 years ago, but also to locate them in order to negotiate whatever agreement. Obviously, this 'complexity' translates into an important cost factor.

In other words, in order to provide access, independently from the purpose (cultural, educational, non-commercial or commercial) and even before getting to the question of remuneration, a significant component of the costs needs to be reserved to identifying and locating the rights-holders with whom, eventually, to negotiate.

At present, FHIs lack the human and financial resources to carry out this type of research that is made particularly complex in the case of cinematographic works for well-known reasons: works can be very old; they are collective works with many individuals or entities owning rights; co-productions are very common; for decades very little (if any) information about authorship was recorded on the work itself (i.e. no 'credits') and factual materials often has no information at all; there are few examples of registers for cinema works across Europe where information can be found; film production companies are often short-lived and chain of ownership is usually not clear; etc.

This complexity and the related cost are undeniable, although it is true that they dramatically decrease with more recent productions and with very well-known titles whose ownership is clear. On the other hand, well-known titles are also those that are more easily accessible via commercial channels, and pose in fact

---

[123] http://www.bfi.org.uk/whatson/bfi_southbank/mediatheque/using_the_mediatheque
[124] http://www.filmarkivet.no/v1/Default.aspx
[125] http://www.ximon.nl/

less of a problem from the standpoint of providing access, as the commercial sector is effectively providing it. The concrete point raised by FHIs rather concerns the large part of European catalogues that are not available – and are unlikely to ever be, considering their low commercial interest.

As all FHIs list broadcasters and producers as their second user group (after scholars and researchers), this complexity in identifying and locating rights-holders limits the possibility of re-using the content for commercial purposes as it adds costs and, perhaps even more importantly in the current audiovisual eco-system, is time-consuming. As a result, EU content is less competitive, and large portions of it cannot be exploited.

This is particularly true for factual footage to be re-used for example in documentaries and TV programs, although it applies also other 'business models', as re-distribution of cinema works on VoD, for example.

From an economic standpoint, this translates into a serious competitive disadvantage that Europe suffers from against countries where the whole intellectual property market is simpler and more efficient, such as the US. This can be seen across the whole cinema and audiovisual sector, as it was recently argued by a study on VoD:

> *Digital distribution of catalogue titles (older works, vintage titles, titles that have not been sold in certain territories) require laborious and costly rights clearance which service providers cannot afford.*
> *This penalises European rights holders, which are often small entities and favours large catalogue owners such as the Hollywood studios[126].*

These are among the reasons why different solutions are currently being explored and proposed to reduce the 'search and locate' component of any mass digitisation-for-access program. In this perspective, solutions aimed at involving authors' societies (with different modalities, including Extended Collective Licensing (ECL), favoured in many Scandinavian countries) seem to be aiming at ways to move resources from non-productive activities of 'search and locate' to remuneration to authors via collective societies.

On the other spectrum of the possible solutions is the position expressed by the ACE (Association des Cinémathèques Européennes) on many occasions, and also in the Position Paper it provided in response to the study's survey. On the subject of digital access for cultural, non-commercial purposes ACE is in favour of introducing or expanding exceptions to that purpose in the EU and national legislation:

> *"A change of EU copyright legislation and its EU wide harmonization are the preconditions for digitising film heritage on a large scale and making it available online. In its reply to the Green Paper "Copyright in the Knowledge Economy", ACE has proposed to implement mandatory exceptions in the EU Copyright Directive[127]. These exceptions should allow:*
> > *- to reproduce the material on any media for preservation purposes*
> > *- to digitise extracts of the material for educational purposes*
> > *- to consult this material online by researchers (pass word protected)*
> > *- to allow access to extracts of it through Europeana*
> *Mandatory exceptions are needed to give public interest institutions legal certainty in fulfilling their public mission. Of course provisions have to be made that these uses do*

---

[126] "Multi-Territory Licensing of Audiovisual Works in the European Union" Final Report prepared for the European Commission, DG Information Society and Media, October 2010
[127] http://www.ace-film.eu/wp-content/uploads/2010/09/Green_paper_ACE_comments_final_01.pdf

> *not conflict with the commercial exploitation of a film, or if a relevant licensing scheme is available.[128] "*

Needless to say that this view is not shared by the associations representing the rights holders, that are generally concerned by 'blanket' exceptions and opposed to solutions similar to the ECL, which might not work well in certain MS outside Scandinavia, where the model has a longstanding tradition.

Clearly, the two issues of resources to clear copyright and to digitise are intertwined, as all major access projects (as those mentioned earlier) are based on an effective working relationship with rights holders supported by some degree of investments from the public sector, for example to pay for the mass digitisation of content, or for an access / VoD infrastructure that allows a remuneration of the rights-holders.

Similar considerations can be applied to the 'orphan works' issue. At the time when this study carried out its surveys, the "Proposal for a directive of the European Parliament and Council on certain permitted uses of orphan works"[129] had not been published yet, and the authors expect that feedback on this issue will come during the open consultation, also taking into account the "Proposal for a directive".

From the point of view of rights, and of access to heritage works, the situation in the US is slightly less complex than in Europe.
First of all, all works produced before 1923 are unambiguously in the public domain in the US, while such a cut-date approach does not exist in Europe. Secondly, exceptions were introduced in Section 108 of US copyright law[130], allowing public non-profit institutions to "reproduce, distribute, display, or perform in facsimile or digital form" a work that is in its last 20 years of copyright and it is not commercially available. Right now copyrighted films from 1923-1933 are eligible for Sec 108h and another year is added each January 1. This exception was introduced in 1998 because the Congress felt that the extension of the terms of copyright had to be balanced by provisions that would still allow access for cultural and educational purposes. As a report from the US Copyright Office states, the explicit rationale behind this exception was the acknowledgment that:

> *"Creative works inspire new creations, which in turn inspire others, but this "engine of free expression" does not function unless the works so created are made available to the public.[131] "*

Implicitly, such an exemption also recognises the fact that older works have a limited commercial value, that the public has a right to access works that have a cultural or educational value but no commercial value (and thus otherwise would be commercially available), and that as a result of the fact that distribution in the media industry is commercially driven, older works are not easily available.

This obvious statement is also confirmed by a simple piece of research about the commercial availability of cinema content on DVD or Blu-Ray according to the year of production, which is shown in the graph below[132].

---

[128] ACE Position Paper sent in response to the study.
[129] http://ec.europa.eu/internal_market/copyright/docs/orphan-works/proposal_en.pdf
[130] http://www.copyright.gov/title17/92chap1.html#108
[131] "The Section 108 study Group Report", An Independent Report sponsored by the United States Copyright Office and the National Digital Information Infrastructure and Preservation Program of the Library of Congress, 2008
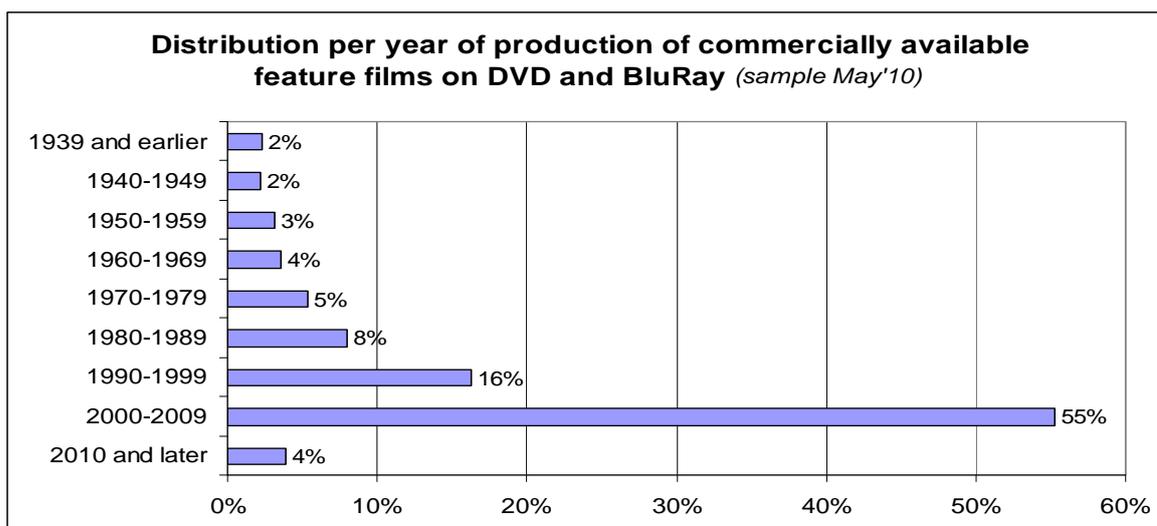
Distribution per year of production of commercially available feature films on DVD and BluRay *(sample May'10)*

Year	Percentage
1939 and earlier	2%
1940-1949	2%
1950-1959	3%
1960-1969	4%
1970-1979	5%
1980-1989	8%
1990-1999	16%
2000-2009	55%
2010 and later	4%

An analysis of the requests for access, the archival DVD sales, and other mixed data, seem to indicate that when offered, the public is interested both in narrative feature film as well as in 'other materials', such as documentaries, newsreels, factual, animation, commercials, amateur films, etc. In other words also parts of film history that are considered 'minor' are of some level of request to the general public. A similar trend is also to be noticed in 'professional' access from researchers and scholars and from broadcasters, with both these groups expanding their interests beyond the traditional concept of 'film content'.

From a technical standpoint, digitisation for access is done according to a wide range of workflows, using a wide range of tools, depending on the type of access and on the available budget.

Following several studies (notably the results from the EU Projects FIRST, PRESTO and EDCINE) it results clearly that a large part of the costs involved in digitisation lie before and after the actual scanning or telecine.

Selection of the material to be digitised, identification of the right element, preparation and repair, cleaning, and subsequently cataloguing, metadata enrichment, re-formatting, and so forth are all steps that are required for a digitisation process and that are rarely calculated in the hard costs. The result is that FHIs tend to agree that digitisation should be done as few times as possible. In practice this means for example that digitisation should be done at the highest possible quality that might be reasonably required. So, if the images are meant for a website or for Europeana, but if there is a reasonable possibility that a broadcaster might ask to re-use them, it makes probably sense to scan them at HD quality, as SD is not requested anymore.

Also, from a purely economic standpoint, the difference in cost between an SD and an HD scan are dropping dramatically in most European markets, as the same machines are often used.

---

[132] Data derived from Amazon.co.uk, June 2011

Summary

- Most if not all FHIs provide some sort of digital access to their collections
- Most if not all FHIs have digitization programs, and some are getting equipped internally
- Digital access is performed alongside the traditional 'on film' access that most FHIs provide
- FHIs provide most digital access services to two categories of users: researchers and scholars on one hand and commercial users (mostly broadcasters) on the other
- the general public is being largely served by theatrical projections or by DVD distribution
- In some cases, more structured ways of accessing the collections on-site are possible, for example with workstations and servers from which digitized content can be browsed and accessed on the FHIs's premises.
- The examples of online access are so limited in scope and in size that they hardly make up significant examples and case studies.
- According to FHIs the blocking factors to access are the lack of resources to digitize, and copyright restrictions
- FHIs are in favour of broader exceptions allowing cultural, non-commercial uses of collections; although this view is not shared by the industry.
- In the US, the legislation allows FHIs to provide access to a larger percentage of their collections

This is obviously not a general rule, and some FHIs got equipped internally to carry out low-quality scans assuming that if a demand comes, a film can be digitised again at the requested quality.

In the choice of quality levels at which to digitise, considerations on storage and preservation can play a significant role. Scanning at high quality a large quantity of materials implies a high budget for storage, with only a small percentage of the digital collections ending up being used at high quality.

3.4.2   Film Heritage and Europeana

The opportunities & the roadblocks

There is hardly any FHI in the public sector that is not supportive of the idea of general access to at least parts of its collections, for educational and cultural uses only, and that does not see Europeana as an unprecedented opportunity to not only give access to its collections, but to be able to contextualise them with other types of documents and collections.

While no FHI thinks that a centralised digitisation and/or storage facility is a viable solution or that it provides any advantage from the technical or economic standpoint, they all agree that a unified point of access to Europe's heritage institutions is a welcome project and that naturally cinema collections should find their place there.

When it comes to the question about the "roadblocks" and the factors limiting the presence of cinema images on Europeana, there seems to be a large consensus amongst public FHIs that the most important factor is the complexity of clearing copyright, as in the case of other online access models.
They also point out that the complexity of locating and negotiating the rights grows exponentially whenever projects aim at access across territories (as for example Europeana, or others). Such projects can be sometimes possible for one or few territories, but with the fragmentation of the European market where rights were and are managed at national level, clearing rights become too complex and thus too expensive and time-consuming.

FHIs also point out to costs, and budgetary limitations as limiting factors, and stress the fact that very few Member States took into consideration the advent of Digital technologies and therefore increased the FHIs' budgets to support digital preservation and digital access. In other words, many digitisation plans are now funded by cutting other services, and this is not sustainable in the long term, particularly when FHIs will have a significant influx of born digital materials to preserve.

Still, although some consider budgetary limitations as critical, the weight of copyright concerns is by far predominant, and given more attention than other factors, also because some FHIs point out that funds could be found or invested, if there was a chance to make some content available, but under the present circumstances they find it difficult to justify.

Some FHIs also show concerns to the Europeana policy that make metadata available for re-use, whether commercial or non-commercial. Some FHIs providers are not fully prepared to waive all rights on their metadata and to allow display of their data in commercial contexts.

After projects such as European Film Gateway[133], technical issues do not seem to be of significant concern for FHIs in order to provide content to Europeana.

---

[133] http://www.europeanfilmgateway.eu/

Summary

- All public FHIs support the idea of general access to their collections,
- All FHIs see Europeana as an unprecedented opportunity to not only give access to its collections, but to be able to contextualize them with other types of documents and collections.
- FHIs think that a centralised digitisation and/or storage facility is not a viable solution
- All FHIs agree that a unified point of access to Europe's heritage institutions is a welcome project and that naturally cinema collections should find their place there.
- Regarding the roadblocks to provide more content to Europeana, FHIs refer to lack of funding for digitization, copyright restrictions, and IPR on metadata.
- After projects like European Film Gateway[1], technical issues do not seem to be of significant concern for FHIs in order to provide content to Europeana
- All FHIs see Europeana as an unprecedented opportunity to not only give access to its collections, but to be able to contextualize them with other types of documents and collections.

3.5 Digital Cinema and Film Heritage

3.5.1   D-Cinema specifications and archival films

Digital cinema has been discussed since the mid 1990s. The biggest concern within the industry was to achieve the same image quality for digital cinema as has been provided by 35mm film prints. The second concern was to create a standard that would provide sufficient protection against theft of copyrighted material in pristine digital quality. Above all was the requirement to agree on a common standard that would be valid worldwide in order to be viable for the global business of film distribution and exhibition. In this aspect the common standard of 35mm had to be replicated in the digital world.

In 2005 the Digital Cinema Initiative, a collaboration of the originally seven major US studios, agreed on the DCI recommendations[134]. Since the DCI is not a standardisation body these recommendations were then to be turned into specifications and standards by the appropriate institutions, namely the SMPTE and ISO. Within the process the European Digital Cinema Forum was founded in Europe (in 2007) to take part in the creation of these global standards.

The DCI specifications were made for the distribution and exhibition of commercial theatrical feature films. Consequently the needs of archival films but also of those that were produced for TV were not considered in the original version. Once it was published several dedicated organisations, namely the International Federation of Film Archives (FIAF) and the European Federation of Cinematographers (Imago), pointed out this lack of consideration and made the case to SMPTE to extend the standards. In an open letter to SMPTE DC28 in 2007[135] the FIAF underlined the need for more flexibility regarding different frame rates. In the original version only two frame rates were proposed: 24 frames per second and 48 frames per second.

The issue with frame rates is that audiovisual works have been produced at several different frame rates for various reasons. With a limitation to 24 fps these works could have not been projected truthfully to their creator's artistic intention. In 2009 the SMPTE published additional frame rates of 25, 30, 50 and 60 fps providing support mainly for works that were created for TV[136]. In 2011 the SMPTE published another document in this regard allowing the use of frame rates of 16, 18, 20 and 22 frames per second[137].

Solving this issue was key in the view of FHI specialists that now consider that D-Cinema standards as they are being approved are generally sufficient for the use with archival materials (this seems to be the dominating view according to the responses to the survey and the in-person interviews).

---

[134] http://www.dcimovies.com/specification/index.html
[135] http://www.fiafnet.org/es/publications/Hollywood%27s%20frame%20rates.pdf
[136] http://www.imago.org/index.php?new=76
[137] For technical reasons the actual frame rates are in fact 16/1, 200/11 (=approx. 18.18181818), 20/1 and 240/11 (=approx. 21.8181818).http://store.smpte.org/product-p/st%200428-21-2011.htm

3.5.2   D-Cinema and Access to collections

3.5.2.1 Adopting D-Cinema

The average cost for a digital 2k projector and server installation made for smaller screens (10m to 15m) and screening rooms and hence less light intensive can be currently seen at around 70k EUR. Lower prices are often achieved in conjunction with bulk purchases.

If the projection booth needs to be adapted to accommodate for air condition and side-by-side installation of digital and 35mm projectors, this cost of adoption increases. On average an adaptation of a screening room should not be more expensive than 10k EUR.

Most FHIs have a regular activity of programming films in their own internal theatre, and almost all of them have a differentiated programming that also includes recent films, premières, etc. Mostly due to this fact, 75% of the FHIs who responded and who have a theatre, responded that they were equipped for digital projection or that they were going to be in the near future, the others were trying to raise the funds or their funding agency's attention in order to equip themselves.

3.5.2.2 Access via Digital cinema: the workflow

As mentioned before security of the audiovisual material has been one of the main aspects of the DCI specifications. Any digital format provides the possibility to create lossless copies of the content, which has to be prevented in order to secure the business model of film exploitation as it is today. The workflow of digital cinema distribution and projection reflects these aspects.

After post-production the result of the production process is a digital master. This master can be produced in a variety of formats, including HD video, and it is usually uncompressed and never encrypted. This master is called the Digital Source Master (DSM) and it is not standardised.
In the following step, from the DSM a Digital Cinema Distribution Master (DCDM) is produced. This is an uncompressed, unencrypted master format that is clearly defined in the D-Cinema standards.
From the DCDM, the "digital prints" are produced, the DCPs. The DCPs are compressed and usually encrypted according to the standards. Although the encryption is optional in the standards, it is commonly used in the commercial distribution.
The encryption process has two steps: 1) the content is encrypted with a key and 2) that key is encrypted again using specific parameters that are unique to each projector, producing the Key Delivery Message (KDM). This way a DCP can have several KDMs. For example, if a cinema wants to project the same film on several
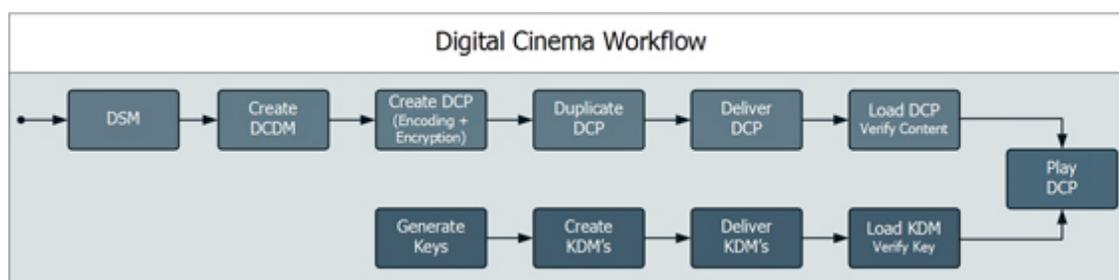
Digital Cinema Workflow, © ARRI

© European Union, 2011

projectors in different screening rooms, it only needs one DCP of that film with KDMs for the projectors it wants to use the DCP with. Hence archives can reuse DCPs after their commercial exploitation, if they obtain a KDM that works for their digital projection equipment. This workflow has been illustrated below.

Distribution channels of within digital cinema are currently on hard drives, via broadband or via satellite. So far hard drives are the most used option, partly due to lack of appropriate infrastructure (broadband) and high costs (satellite). For distributors it is also beneficial to maintain established relationships (and price agreements) with physical film delivery partners during the transition period from 35mm to digital exhibition.

3.5.2.3 Access via Digital cinema: the costs

There are three separate costs involved with accessing digital cinema:
1. Digital Master
2. Digital distribution
3. Digital exhibition equipment

Digital Master: Nowadays the majority of film postproduction is done digitally. Hence the production of a digital master is becoming more and more a part of the production budget rather than part of the distribution costs. Costs of digitisation for FHIs were discussed in an earlier section, and at this point for comparison purposes, we assume that the FHIs already possess a digitised version at the required resolution (minimum being an HD 1920x1080 version).

Digital distribution: The digital master has then to be transferred into the Digital Cinema Distribution Master (DCDM). This master is used as an intermediary step to encode digital 'prints' or DCPs, Digital Cinema Packages. Prices for these processes vary, but according to industry sources average costs for the different steps of D-Cinema mastering can be calculated as follows: € 1,500 to €5,000 for the creation of a DCDM from a DSM, and a similar amount for the encoding of the DCP, depending on services included, length of the film, subtitling, etc. Once a DCP is encoded, the cost of each subsequent copy is of approximately €100

In addition there is the cost for the Key Delivery Messages (KDM) that is around €20. Further distribution costs such as delivery fees/ postage depend on the distance and route that has to be covered but can also be assumed as rather low (€15 to €50, definitely lower than for a 35mm analogue film).

It is also useful to point out that technical solutions exist for FHIs to produce DCDM and DCP internally, with consumer/prosumer hardware and specialised software (also some open-source-solution). Overall costs of an internal solution is as low as twice as much as the creation of one DCDM/DCP.

Equipment: As mentioned earlier, the average cost for a standard 2k projector and server installation is about €70K.

Taking all three aspects together we can make a comparison to the existing situation with analogue 35mm distribution.

Analogue distribution is based on one or more (depending on the number of prints required) 35mm internegative that is usually recorded from a digital file of the finished production. Costs for an internegative vary, but can be estimated at around €25K for a 90min film. Costs of producing the distribution prints obviously vary, depending on the market and on the number of prints required, but a reasonable average is around €2K per print.

In summary, distribution costs are definitely lower in the case of digital distribution.
For the mastering "phase", €25K for an internegative compares to costs between €3K and €10K for the digital chain, and as it was mentioned, in-house solutions are also possible or FHIs and small productions to further reduce costs.
At the stage of producing prints, the difference is even greater, with digital costing less than 10% of a film print.

Summary

- After archival frame rates (allowing films to be shown at the native speed) were approved as part of the D-Cinema standard, the standards do not pose excessive problems in screening archival content
- As most FHIs program also modern cinema, 75% of the FHIs who responded and who have a theatre, responded that they are equipped for digital projection or that they were going to be in the near future.
- D-Cinema reduces significantly the costs to re-distribute archival content, particularly because D-Cinema 'prints' can be produced directly by the FHIs at very low cost.

3.6 Awareness and readiness

3.6.1 Perceived awareness of key stakeholders

Measuring awareness and readiness is not an easy task, as it is difficult to measure it in an objective way.

The study took two opposite approaches.

The first was to include in the surveys a specific question, asking the respondents to score the awareness they *perceived* in different groups of stakeholders: their own institution/association/company, the FHIs in general, the cinema industry, their own Government (from which most FHIs depend directly or indirectly for the funding they receive), the European institutions (this is clearly a rather vague concept, but it was included as a potentially useful indicator, while further differentiation within the EU Institutions has been considered potentially confusing), and finally the technology vendors that the respondent deal with when it comes to digital planning and projects.

Approximately 82% of the respondents to the survey included an answer to this question, and the results are given in the table and graph below. Not all of those who responded to the question gave a score to all categories; 'EU institutions' for example was a category for which some 20% of those who responded did not express an opinion.

Not surprisingly, the average response is high for 'My institutions', this is due in part to the fact that the institutions/groups who participated in the survey were also those who are more responsive to the issue. Similarly high is the score for FHIs, as the sample of respondents was clearly skewed in favour of FHIs.

It is interesting to point out that National Governments scored rather poorly, definitely worse than EU institutions on both digitisation and preservation, and only slightly better than the cinema industry regarding 'preservation'.

Another clear pattern is that respondents felt that the awareness and attention to digitisation far surpasses that on preservation issues. Preservation scores relatively low across all groups, except FHIs, while digitisation is definitely a 'hot topic' for the industry and for the technology vendors.

3.6.2 Readiness

The second approach taken by the study concerning awareness and specifically readiness, was simply to analyse the replies to the survey and the content of the interviews.

To some extent this work of analysis confirmed a very mixed picture that, interestingly, corresponds to a good extent to the results of the survey.

The quality of responses to the survey showed that in fact FHIs are seriously concerned and aware of the principal challenges that they are facing.

This is not too surprising as FHIs as a group started the very earliest project designed to analyse the impact of digital as early as in 2002, with the EU-funded project "FIRST-Film restoration and Conservation Strategies" that published its final report in 2004. Other EU projects followed, focusing either on access to the collections (MIDAS that later evolved into EFG - the European Film Gateway[138]) or on technical solutions for digital preservation (EDCINE), plus some FHIs participated in other projects (as PRESTO, for example) at EU or national level. And numerous conferences and workshops were organised since 2002. The FIAF Technical Commission was actively engaged with SMPTE in defining the standard for archival frame rates for D-Cinema, and with ISO for the standardisation of the already mentioned JPEG 2000 profiles for long-term preservation.

So in fact FHIs have been rather active and this shows a fairly high level of awareness.

As it was discussed in the introduction to this study, there a body of documents from EU institutions that show a good understanding of the issues that faced the FHIs before and after the advent of Digital. Again, the level of awareness is evident.

FHIs tend to point out that the overall level of support that they received from the various EU programmes is not as high as they wish (the relevant programs are those listed above, so basically four in a period of 9 years, with no support for digitisation). Of course the issue refers also to the quality of the projects submitted by the FHIs, but it is worth mentioning as it has been reported.

The situation seems to be less positive when it comes to National Governments. Clearly, the already low score they received (2.8 and 2.2) would drop even more if we remove from the respondents the Institutions in Scandinavia and in the Netherlands. Outside of these two areas, the respondents had a fairly negative view on the awareness and the level of initiatives at national level.

In a way, this is also something that transpires from a careful reading of the two Implementation Reports concerning the 2005 Recommendation on film heritage that does not show significant progress in many areas, particularly between the first and the second. In addition, this is confirmed by the evidence of the initiatives around the 27 MS on digital access and preservation.

The issue is not that nothing is happening, but that actions do not seem to be such to significantly impact the picture.

This, in turn, is also confirmed by the fact that (with usual exceptions), basically no FHI sees itself ready and equipped (in terms not only technical, but also of budget, staff, and strategies) to face the "digital tide" they face.

In other words, awareness is fairly high, but FHIs judge their readiness as insufficient.

We have already commented about the industry. In this case the best way to judge its readiness and awareness is to benchmark with the situation in North America. Again, the analysis of the respondents seems to be correct. The European industry is embracing digital in terms of a potential new market, and it is slowly experimenting with new business models, it is ready to collaborate with FHIs and national governments on access projects, so, in short, it shows awareness and

---

[138] www.europeanfilmgateway.eu

interest in the field of digitisation and digital distribution, but it does show hardly any sign of being active on the issue of preservation of its digital works.

To be fair, it is true that the industry (from production to distribution) is already undergoing a wide range of changes (last but not least the digitisation of the theatres) that are seen as more urgent than long-term preservation.

This of course is a simplification, and it does not exclude that many producers and distributors are seriously concerned and they are doing their best; it simply records that industry-wide there is no sign of activity.

Another interesting fact that does not refer to Digital Preservation only, but more generally to the preservation of cinema whether analogue or digital, is that differently from any other industry, the concept of 'life-cycle' is completely absent from basically all documents, studies and models that were accessed for this research study, be they from government bodies, from the European Audiovisual Observatory, industry organisations, or even the European Investment Bank.

It seems as if the model under which the industry is analysed still corresponds to the linear model that has been in fact outdated for at least three decades, with the life-cycle of a cinema 'product' basically ending with the theatrical distribution.

This is mainly the reason why basically no hard data are available regarding the economic value of cinema works after the end of their theatrical distribution, and hence about the economic value of FHIs collections for Europe. The lack of basic instruments of analysis makes it difficult to concretely contribute to a discussion about business models, new distribution channels, and value over time – which is obviously directly connected to the potential investments in preservation.

As a result, also policies fail to take into consideration the whole cinema life-cycle. A perfect example is the whole discussion about the conversion to Digital of European screens, where very little attention is paid to the effect that the digitisation of theatres will have on the whole value-chain, from production to exhibition and preservation, and on the existing catalogues. By reading most of the documents and policies, one would have the impression that the problem is strictly limited to the exhibition sector, that it is 'just' a matter of funding the purchase of new equipment, without assessing the impact this has on the industry as a whole.

Considering the whole life-cycle of a product such as cinema works might actually help put preservation and access into perspective, as at the moment it is really anybody's guess.

Summary

- Responses to the Survey indicate that awareness is high in the FHIs
- Awareness is seen as low at national government level, but good in the EU institutions
- The industry is perceived to be highly concerned with digitization and not to be aware of preservation issues
- In broad terms, this picture is confirmed by the data gathered by the Study.
- In terms of readiness the bottom line is that no group of stakeholders is 'ready', despite the many projects and activities carried out by the FHIs.

	Score: 1= very poor to 5= very good	
PERCEIVED AWARENESS	on digitisation	on preservation
My Institution	3,8	3,7
FHIs in general	3,6	3,4
Cinema Industry	4,1	1,9
My Government	2,8	2,2
EU Institutions	3,4	2,4
Technology Vendors	3,8	2,6
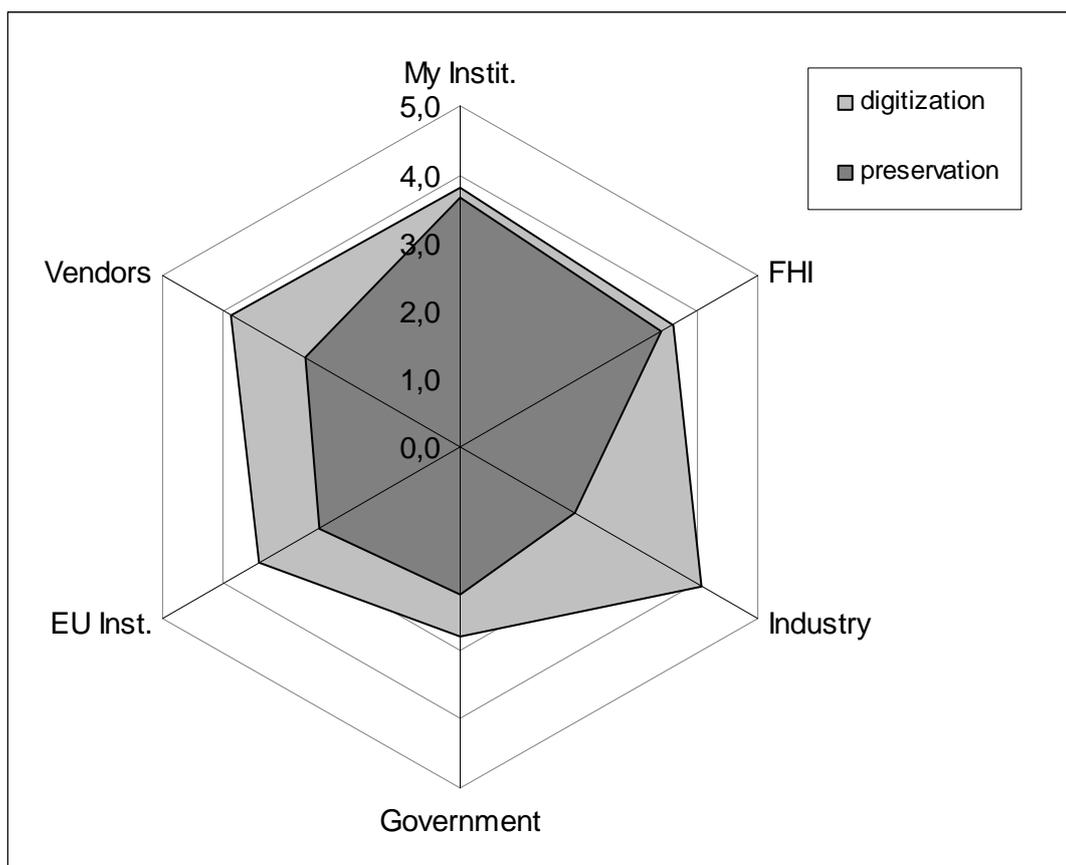
3.7 The costs of action and costs of inaction

Throughout this study, projections for different categories of costs have been given, and are all summarised in this section in order to have them available at a glance.

As it has been said throughout the text of the study, these are projections that are based on the available information and on a number of assumptions that were further detailed in the text. As all projections based on a number of assumptions and hypothesis, the end result might change, even significantly, if some parameters are modified. The authors however think that these projections draw a reasonably accurate picture of the *scale*, i.e., the order of magnitude of the investments required.

3.7.1 The cost of collecting and preserving in digital format all cinema works produced in Europe.

On the assumption of a total production of 1100 feature and 1400 short films per year, the resulting requirements in terms of volume of data is projected in **5.8PB per year**.

At a projected cost per PB of managed storage (based on projections of technologies available in 2015), this corresponds to an annual cost of **€1.45M / per year**.

Apart from the preservation costs, the FHIs must acquire the necessary equipment, staff and competence in order to carry out this task.

Based on the analysis of the current situation within the European FHIs, on the responses to the Survey, and on models of equipment and staff costs required by FHIs to carry out what is described above, it is reasonable to assume that European MS should increase the overall funding of the European FHIs for approximately €60M / year.

The cost of digitizing the whole European film heritage

The projection is based on the assumption that the entire European Film Heritage amounts to a total of **1M hours**. This hypothesis is in fact rather high, and it represents the worst case scenario.

Digitisation costs are projected to be between **€500 and €2000 per hour of digitised material**, considering that this is an average that covers a wide range of quality levels as any mass digitisation project will be in fact a mix of different titles digitised at different qualities and with different techniques.

Digitisation costs for the whole European film heritage would then result in **a total ranging between €500M and €2B**.

The cost of preserving the results of the digitisation

If the whole of European Film Heritage is digitised (a target that is not considered realistic), this is projected to **amount to 1,050PB**. When the cost model for long-term digital preservation costs is applied to this amount, the result is an overall cost of **€145M per year**, or an *average* of €5.3M per Member State.

The authors want to stress once more that these costs and investments are to ADDED to the current budgets of the FHIs, as the care of digital works does not REPLACE the care of analogue collections, but it goes along with it. Economies are theoretically possible, and the accumulation of experience in the FHIs will definitely allow for economies in the future, but not within the timescale of this projection.

Another possible exercise is to project all the costs mentioned along this Study over the medium term, the 7 years that are considered a reasonable span of time for the digitisation process. The results of this exercise are obviously theoretical, but they can be useful to visualise the dynamics of the costs.
The table below is designed to show these dynamics.
The following criteria were followed in designing the table:

- New productions represent 5.8PB per year, and the costs to store them are calculated as decreasing over time: €290K for the first 3 years, then €145K.
- As overall cost of digitisation, €1B was chosen as it is the median cost (between €500 and €2000 per hour); alternative scenarios can also be covered by this figure, as a higher cost for a lower number of hours (which is more realistic). For sake of simplicity, this amount is spread equally over the seven years.
- Storage requirements are based on one Exabyte being required for 1,000 hours of digitised material. Again, for sake of simplicity this is spread equally over 7 years.
- A lump sum of €60M is calculated in order to support the FHIs in the transition (training, hiring, purchase of equipment, research, etc.). This amount is to decrease to by half after 4 years when it is expected to cope only with changes in technology.
- The average per MS is purely indicative and it does not take into consideration the differences among MS in terms of size of production and heritage.

Costs for Digitisation and Long-term Digital Preservation *(millions euro)*									
		year1	year2	year3	year4	year5	year6	year7	year8
Cost of Digital storage for new productions	M€	1.68	3.36	5.05	3.25	4.06	4.87	5.68	6.50
Costs of digitisation	M€	142.86	142.86	142.86	142.86	142.86	142.86	142.86	
Storage requirements	in PB	142.86	285.71	428.57	571.43	714.29	857.14	1.000.00	1.000.00
Costs of storage for digitised content	M€	20.71	41.43	62.14	82.86	103.57	124.29	145.00	145.00
Cost of equipping FHI	M€	60.00	60.00	60.00	60.00	30.00	30.00	30.00	30.00
Total Cost per	M€	165.25	187.65	210.05	228.96	250.49	272.01	293.54	151.50

year								
Average per MS EU27	M€	6.12	6.95	7.78	8.48	9.28	10.07	10.87	5.61

3.7.2   The costs of inaction – the economic impact

"How much would it cost Europe NOT to act on these issues?"

The study was required to give an answer to this question, in other words to assess the impact of inaction on the broad issues of collection of contemporary productions produced digitally, of digitizing the European Film Heritage in order to provide access in a Digital world, and of Long-term Digital Preservation of these two sets of works – born digital and digitised.

Clearly, a lack of action in the 8 years that are considered for the above projection will result in two major effects:

- **A loss of newly produced films due to lack of serious long-term preservation**
- **And the non-availability of any film that is not digitised**

It is virtually impossible to predict what percentage of newly produced films would be lost in the next 8 years if no actions are taken. As media migration should happen every 5 years, it is not unrealistic to assume that 20% of works produced in 2011 (i.e. 220 feature films and 280 shorts) will be lost by 2016, the same amount of films produced in 2012 will be lost in 2017, to which another number of films produced in 2011 should be added. Aggregated losses in 2017 might reach the number of 330 feature films and 420 shorts, and so forth every year.

Assuming that public funding of cinema production and distribution remains at the same level, and using the figures that we quoted earlier (a combined €2.6B per year) and assuming that 80% goes to feature films and 20% to shorts, this means the MS will loose €520M in investments in film works because the works supported in 2010 will be lost. In 2017 the combined loss of more films produced in 2010 plus those produced in 2011 will produce a loss of €780M, and so on.

These losses (inevitably theoretical) can be avoided by an investment of less than €10M (or some 2% of the projected loss) in the five years from 2012 to 2016.

As we wrote earlier, VoD market is projected to reach the €2B threshold in 2013. This might be an optimistic target. As a benchmark we could take the revenues deriving from cinema content on VoD[139], which amounted to €61M with a growth of 115% against the previous year. If we simulate a lower annual growth (50%), that market should reach €1B in 2016. This is the figure that would be affected by a loss of European content produced in the 5 previous years. Even assuming a low revenue level from 'old European films' on VoD, the differential between €1B as a potential market and €21,75M as the cost to make sure that no content is lost, is definitely significant.

---

[139] Source: European Audiovisual Observatory, Yearbook 2010

The home-video market (DVD+Blu-Ray) amounted to €9.5B at the end of 2009. As we know the market is shrinking (in terms of revenues, not so much in terms of transactions, i.e. units sold or rented), but assuming that it contracts at a pace of 10% every year, in 2016 it will still be worth €4.5B. How much of this market concerns European catalogue titles is not known, but again the differential with the proposed investment is still huge.

The economic implications of the non-digitisation of the European films of the past is the object of several statements, one of the most clear and strong comes probably from the 'Common Declaration in Support of Digital Cinema', signed in 2005 by the members of EFAD- European Film Agency Directors:

> *The EFADs therefore believe that it is absolutely necessary that the largest possible catalogue of new and classic European films is available in the appropriate HD digital format for VOD, web and cable-based home video services, or in the DCI-compliant 2k to 4k digital format for theatrical screening. With the American majors moving quickly into the VOD and digital cinema market, with large and compelling libraries of American titles, there is a real risk that European films will lose out and never reach a new and committed audience if European producers, distributors and exhibitors are unable to respond speedily to the digital challenge. Effective support measures with a view to encouraging the digitisation and digital distribution of films are critical to the development of both digital cinema exhibition and of VOD platforms and are needed at both the national and the European level.[140]*

The text has the great advantage of posing the issue from a strategic point of view, in which the digitisation and the availability of a critical mass of good quality digital content for distribution via VoD and D-Cinema channels is seen as a critical 'competitive advantage', without which Europe risks losing even more ground against US companies, which undoubtedly come with a remarkable amount of high-quality digitised content ready for distribution.

> ### Summary of estimated costs
>
> - Digitisation costs for the whole European film heritage would then result in **a total ranging between €500M and €2B**.
> - If the whole European Film Heritage is digitized, this is projected to **amount to 1,050PB**
> - the result is an overall cost of **€145M per year for long term preservation**
> - These costs and investments must be ADDED to the current budgets of the FHIs, as the care of digital works does not REPLACE the care of analogue collections, but it adds to it.
> - A lack of action would result in a
>   - **A loss of newly produced films due to lack of serious long term preservation**
>   - **And the non-availability of any film that is not digitized**
> - Projections for loss of new productions are calculated at 220 feature films in 2016 and 330 in 2017 and onwards.
> - Public funds invested in these works are calculated at between €580M to €780M per year
> - These two factors will negatively impact European competiveness in several fields, such as VoD, home video distribution, TV market,
> - The cultural impact of the complete disappearance of European film heritage is also a serious concern, as higher education in anything media-related will be impossible.

---

[140] http://www.filmcouncil.org.uk/media/pdf/j/f/Common_declaration_on_Digital_Cinema.pdf

3.7.3   The costs of inaction – the cultural impact

> *"Not everything that counts can be measured, and not everything that can be measured counts"*, Albert Einstein.

The authors of this study are convinced that it is not necessary to insist on the concept that European and national culture, history and identity are values *per se* even if it is not possible to attach a euro price tag on them.

The lack of investments in the digitisation of the cinema of the past, and in the preservation of the cinema of the future will obviously have a devastating effect on the European culture.

It has been said in a number of occasions that moving image content is the most accessed and sought after on Europeana. This is hardly surprising, as the younger generations have grown up in world of moving images.

Moving images - be they TV, cinema or even video games - are based on a language whose understanding is fundamental for anyone living in the 21st century. Letting 120 years of European cinema images disappear will only result in a wasteland inhabited by new generations unable to understand what they access most: moving images.

As one of the study's interviewees, a professor of film studies, pointed out, cinema continues to be the point of reference for all sorts of visual communications and media. TV fiction, series, soaps, and increasingly games and virtual reality draw heavily from the imagery and the language of cinema. This is one of the most used languages in the contemporary world, far more important, in a way, than English, Spanish or Chinese for whole generations of Europeans. How can we expect them to understand our world if they ignore its most largely used language?

> *"These are early days for the digital economy and as it continues to develop the demand for audiovisual works will grow exponentially. To satisfy that demand **the industry depends on the talents of the creative community** – in particular screenwriters and directors.*[141] *"*

This quote from a document of the Society of Audiovisual Authors is a perfect point to introduce another key concept. Screenwriters, directors, but also cameramen, editors, actors, etc. are the ones who really create the European audiovisual industry, which is valued at more than €108B.

This means that at least a significant share of that value is due to authors who developed their creativity by studying in Europe's higher learning system of schools and universities.

If Europe lets European cinema disappear, how can it expect to grow the next generation of creatives to nurture and expand its cinema and audiovisual industry?

---

[141] From: Audiovisual Authors' Rights and remunerarion in Europe, a SAA (Society of Audiovisual Authors) White Paper http://www.saa-authors.eu/dbfiles/mfile/1400/1468/SAA_white_paper_english_version.pdf

Obviously, the impact of literacy in cinema and the moving image, and of the educational potential of cinema and audiovisual in other disciplines at all levels, from primary schools to university should not be underestimated. It is not 'just' a matter of educating and training a new generation of creatives in the audiovisual sector. In a society dominated by images and particularly by moving images, the sudden disappearance of 120 years of cinema history and memory would have a dramatic impact on the whole European cultural sector.

And the cultural sector, at least since the EU "Lisbon agenda", is at the centre of a strategy based on a 'knowledge-based economy'. A rare study on the economy of culture in Europe[142] provided quite impressive figures on the role of culture (in the private and public sector) in the European society. Some of these figures are worth quoting in this context as they are reminders of the economic importance of the cultural sector in the EU:

> *Quantifiable socio-economic impact of the cultural & creative sector (EU30):*
> *- The sector turned over more than € 654 billion in 2003*
> *- The sector contributed to 2.6% of EU GDP in 2003.*
> *- In 2004 5.8 million people worked in the sector, equivalent to 3.1% of total employed population in EU25.*

---

[142] "The Economy of Culture in Europe" study prepared for the European Commission - Directorate-General for Education and Culture, October 2006. http://www.keanet.eu/ecoculture/studynew.pdf

4. Learning from others

4.1 The Broadcasting sector: INA

4.1.1　Introduction

The French "Institut National de l'Audiovisuel" [143] (INA) was created in 1974 and is responsible for the preservation and management of the audio-visual heritage of France. The archives of INA date from the earliest radio and television productions, that is, over 60 years of television and 70 years of radio. Approximately 7M hours of material are held in a variety of different formats.

INA has the legal responsibility for the capture and archiving of French radio and television broadcasts ("dépôt légal") which are then rendered consultable at the 'Inathèque' in the Bibliothèque François Mitterand and in the six regional centres of INA. Currently, approximately one million hours of radio and television programming are archived per year.

INA has the possibility to commercialise programme content within its archives for which it holds the producer property rights.

INA is also a competence centre for skills related to the preservation and restoration of audio-visual heritage with its own research activities, offering training, consulting, and degree courses.

4.1.2　Digitisation Programme

INA has embarked on a program of digitisation in order to preserve the contents of its archives. This presents specific challenges.

The physical media held by INA covers the entire history of broadcast recording including 16mm and 35mm film, and a wide range of analogue and digital videotape formats, many of which are now obsolete. The quality of material in the archive varies, and each format presents its own challenges for being digitised. The major classes are digitisation from film and digitisation from magnetic tape.

The majority (70% - 80%) of digitisation is straightforward requiring about 1.5 hours of work per hour of programme (excluding cataloguing and documentation). The remaining 20% - 30% present difficulties due to the state of the material and require between 3 and 4 hours of work per hour of programming.

4.1.2.1　*Challenges of Film Digitisation*

INA has around 200,000 hours of film in its archives, for the most part dating back to the period before videotape recording became possible.

---

[143]　Special thanks to Gilbert Dutertre, Jean-Michel Rodes and the team at INA for providing the background information for this section.

Digitisation does not include restoration, and the latter is considered a separate operation if there is sufficient commercial interest. The cost of digitisation varies, but it can be as high as €3K – €4K per hour, depending on formats and conditions.

Unlike cinematographic archives where a film work is most likely to be a finished master or release print, the film material contained in the INA archives was of TV programmes destined to be transmitted over the air. Preparation of film for digitisation involves the following steps:

- An initial cleaning of the film to remove obvious dust and other contaminants.

- Inspection of the film for specific characteristics that may impede digitisation. An example is where the archived film contains glued splices. Over the years, the glue in the splice will have diffused and become attached to the adjacent layers of film in the reel and the splice itself may have failed. In this case, the affected areas need to be specifically cleaned and the splice re-mounted.

- If the film has been badly handled (by out of alignment machinery, for example), the sprocket holes may need to be repaired.

- After preparation, the film is scanned through a telecine that is capable of handling old film stock of various formats, for example, the BTS FDL-90 which can convert 35mm, super 16mm and super 8mm film stock, and which directly produces a full resolution digital RGB video stream at standard definition (SD[144]) resolution.

- An additional challenge is that telecine equipment available on the market is designed for new film stock, whereas there is a specific and unresolved requirement for equipment that will better handle old film stock from archives.

4.1.2.2 Challenges of Videotape Digitisation

Magnetic tape follows a similar process of inspection, preparation and digitisation.

The tape is cleaned to remove excess magnetic material and other contaminants. If magnetic tape is not used for an extended period of time, the tape may 'stick' and refuse to unwind, in which case the tape must be treated before cleaning.

The tape is then played on the videotape recorder (VTR) corresponding to the format of the tape. As each VTR may have been adjusted differently when the recording was made, it is also necessary to be able to make a controlled misalignment of the VTR used for digitisation of the videotape.

4.1.2.3 Hardware System Obsolescence

A difficulty common to both media is that in order to read obsolete formats, it is necessary to maintain not only the media, but also the ecosystem of hardware equipment

---

[144] Standard definition is 720 pixels horizontally by 576 lines vertically at a 50Hz field rate (25 complete images per second).

Maintaining such an ecosystem requires skill, understanding, and experience of the underlying technologies, systems and equipment in use. As time progresses, preserving the ability to read the original media will present challenges:

- Maintaining the range of VTR and telecine equipment in a working state: The majority of specialised components for the VTRs are now obsolete and becoming unavailable. Cannibalisation from the second hand market is a limited option.

- Maintaining ancillary equipment in the ecosystem: A VTR will not always operate in a stand-alone environment and requires other studio equipment to create a fully functional environment. This equipment is also subject to obsolescence as the broadcast industry migrates to high definition digital formats.

- Preserving the skill base: Maintaining and operating the set of equipment required to play the wide range of formats requires an in depth knowledge and experience of the operating principles and practical characteristics of each recording system. This knowledge will eventually disappear.

4.1.3   Restoration

Restoration of archive content by INA is made in the digital domain. Original source material is always preserved, whether this is film or video.

Restoration work is not undertaken systematically, but is undertaken when there is a commercial requirement. INA defines three levels of restoration, with increasing resources required per level:

- Level 1: All programmes pass through this stage, which provides basic reconditioning of the program. Automatic removal of basic defects is applied such as correction of framing errors. 1 hour of programme requires between 2 and 3 hours of restoration.
- Level 2: This is the most frequent level. Restoration is undertaken scene by scene. Colorimetry is corrected to provide a visual impact similar to current television broadcasts. Remaining major defects are corrected manually. 1 hour of programming requires between 12 and 15 hours of restoration.
- Level 3: The most rigorous level of restoration, with all defects manually corrected requiring several passes through the content. 1 hour of programming requires around 50 hours of restoration.

The primary output format for digital restoration is that of standard TV (SD) resolution, although depending on the archive source and program content, some material is restored directly to HD resolution.

The rationale for this restoration policy is that the vast majority of archive material is shot for television broadcast. All archive videotape material is SDTV. Film archive material exists in a variety of formats, from 16mm to 35mm, but is shot for ultimate TV consumption. Depending on the original format and content, restoration in high definition may justify the additional cost. Otherwise the best HD results are obtained from the restored SDTV via a high quality up-conversion process. INA restores about 300 hours of programming per year.

As the original material remains available, it is not unknown for the same content to be restored more than once, as new commercial demand arises and as new

restoration equipment and techniques become available. Restoration does not have an irreversible impact on the archive collection.

4.1.4 Dépôt Légal

INA fulfils the legal requirements of the "depot légal" via an automated system that captures television and radio stations automatically. The programmes are archived to both LTO tape cartridges and DVD. The LTO format is used for subsequent ingest into the INA archival system. The DVD is used as the support for the consultation services offered by INA (see below).

As indication of the success of the approach adopted by INA, the same architecture also provides commercial content collection services for third party broadcasters.

The INA service collects 100 television channels and 20 radio stations.

4.1.5 Digital Archive Management

INA is migrating its archive content to digital form as a means of preserving the original (in the case of film) and to avoid format obsolescence (in the case of analogue video), and to allow easier consultation, search and access. Original digitisation was in MPEG 2 format, but this has since migrated to using JPEG 2000 in lossless mode. This permits archiving at 4:2:2 resolution and 10 bit precision, comparable with contemporary television studio quality levels.

To maintain consistency with existing catalogue information, the time code of the original material is preserved in the newly digitised material.

The digitisation program has resulted in a current data storage requirement of 2 petabytes.

The architecture of the archive has been designed to be scalable, using open standards and non-proprietary equipment and technologies with well-defined roadmaps for future evolution.

The archive is based on LTO[145] magnetic tape cartridge technology, which is an open format ensuring multiple sources for products and media.

On-line and near-online access is provided by a front-end disc based storage backed up by a robotic cartridge storage and access mechanism and a hierarchical storage manager that handles automated renewal of media when the tape cartridges reach the end of their expected life.

Material recorded from the "Dépôt Légal" content ingest and from the archive digitisation program results in an archive growth rate of 10 LTO tape cartridges per day.

---

[145] Ultrium LTO. http://www.ultrium.com

4.1.6   Property Rights

In common with other organisations charged with preserving audio-visual cultural heritage, INA faces issues with rights to content related to preservation via digitisation. In some respects, particularly when the content is stored on videotape, the problem is more urgent than with film due to the degradation characteristics of magnetic tape and the potential disappearance of working videotape recorders to recover the content.

The issue of rights tracking and orphan rights is one that impacts many organisations in the audio-visual media, and is not limited to cinematic archives. In the case where rights cannot be traced, archives are faced with a choice: Watch irreplaceable heritage disintegrate, or act without legal clearance. Which course of action should the responsible archivist choose?

4.1.7   Access to Archive Content

INA makes available three mechanisms for access to archive content:

- "Inamédiapro": A service for professionals that provides search facilities of the INA archives and the possibility to view online material that has been digitised as well as selecting extracts for subsequent licencing and re-use if the appropriate rights are held by INA or can be identified. A search of the archives by INA's documentalists is also possible.

- "Inathèque": a centre for the consultation of the archives in the context of the "depot legal". This is located in the National Library of France, and may be consulted by students, researchers, professionals and individuals for private research. The "Inathèque" makes available more than 4 million hours of television and radio material for consultation.

- Consultation by Internet. INA makes available, to the public, reduced resolution versions of the television and radio material for which it has the appropriate rights. This amounts to about 30 000 hours.

Video content intended for consultation is encoded using H264 with a data rate of around 400kb/s which allows the content of one channel for one day to be stored on one DVD-R.

Application to the Film Heritage Sector − Lessons Learned

- The position of INA is analogous to that of many FHIs: Much source material is film based, rights clearance issues inhibit preservation and exploitation, and much material is held on obsolete and decaying formats at resolution levels below today's accepted norms.
- INA has developed an educational branch which provides training on a wide range of subjects including emerging technologies for preservation, restoration and access. This could be a model for FHIs to adopt post-digital.
- With agreed formats and responsibilities, the Legal Deposit mechanism functions smoothly, ensuring capture, archiving and cataloguing of television and radio transmissions. Agreement and clear specification of consistent Legal Deposit mechanisms for FHIs across Member States should allow for commonality in workflow, tools and processes leading to harmonised archive management and access across the Community.

4.2 Archiving Space Exploration Data – CNES

4.2.1 Introduction

Founded in 1961, the Centre National d'Etudes Spatiales (CNES)[146] is the French government agency responsible for shaping and implementing the space policy of France in Europe.

Earth Observation and other data collected from space missions have a very high cost of acquisition. Relevance of the data is both immediate and long term. Immediate value derives from the main space mission objectives. Long-term value derives from the ability to access and to analyse long-term time series of data. For example, to aid the understanding of climate change and other long-term phenomena such as the impact of solar plasma on the Earth. The long-term value of data is not always apparent at the time of acquisition.

The CNES has been collecting data, in digital format, for more than 30 years from over 90 space missions of which some are still active.

The collection and exploitation of data for long-term use creates the requirement for an "everlasting archive". Planning for the creation and operation of such an archive requires taking into account the following:

- Data must be preserved for a duration that is much longer than the lifetime of the technologies on which the data is stored.

- Data is preserved beyond the lifetime of the systems and individuals that created the data.

- Data must be preserved under conditions that allow for future exploitation.

Failure to take into account the need for long-term preservation will lead ineluctably to the loss of data.

4.2.2 Initial Data Preservation Experience (1986 – 2000)

The history and experience of data preservation at the CNES provide an insight into the challenges associated with the storage and exploitation of large volumes of data. The SPOT satellite program provides high-resolution earth observation imagery. The program began with the launch of the SPOT 1 satellite in February 1986.

Each pass of the satellite delivers about 5GB of data which is indexed and stored. Data integrity is maintained by a second parallel tape recording. Data recorded on the tape is implicitly linked to the conditions under which they were received.

---

[146] Special thanks to Jean-Peirre Gleyzes, Danièle Boucon, Martine Loroque and Richard Moreno, CNES Toulouse for providing the background information for this section.

Reconstitution of data and/or images from archive tapes must take this information into account.

Initial storage architectures, using then currently available technology, recorded satellite data to magnetic and optical tape[147]. As technology progressed, a greater amount of data could be stored on individual tapes resulting in operational and storage convenience and savings.

Tape storage is both offline and linear. Whilst offline storage has the advantage of not consuming energy whilst not in use, it has the disadvantage of having a long access time (due to manual intervention) and being organised for linear access. For example, access to a time sequence of data is very resource consuming and slow.

The limited lifetime of tape, and advances in technology resulted in data migrations from one format to another, at intervals of approximately 5 years, either planned to take advantage of new technology, or unplanned and driven by the sudden disappearance of proprietary systems from the market. Tape based technology allowed data migration at no faster than real time, resulting in significant resources being required to perform each migration.

As data volumes increased and new technologies became available, the CNES investigated the implementation of more structured 'digital' archive implementations.

A comparison may be drawn between the state of the CNES archive prior to 2000 and the current state of 'analogue' film archives:

- Both Earth observation data and cinematic works have an immediate and evident value. Long-term value is more difficult to quantify, and long-term investment more difficult to justify.
- The preservation of Earth observation data and the preservation of film heritage both require "everlasting archives".
- Access is limited by the effort and cost of recovering information from offline linear records.
- Recovery of original material is slow and costly, limiting potential exploitation.
- Migration to new supports to preserve information is slow and costly.
- Silent deterioration of offline material may pass unnoticed.
- Old support material becomes unreadable due to the lack of availability of reading equipment and/or compatibility with existing systems.
- The use of proprietary formats increases the risk of irrevocable data loss.

4.2.3   The CNES Approach to Structured Data Preservation

The experience gained by the CNES with SPOT and other programmes up to 2000 initiated a reflection as to how data storage and customer facing services could be improved by redeveloping the complete system[148], taking advantage of advances in technology to overcome limitations of current recording systems.

---

[147] Optical tape refers to a technology whereby data is stored on optical media, rather than magnetic media. In the 1990s it was projected that optical tape would be commonly used for high-speed, high capacity, long-term computer data storage. One former manufacturer of optical tape recorders, Creo, was acquired by Kodak in 2005.

[148] Reflections underway at the CNES and in other national space agencies resulted in the publication in January 2002 of the Consultative Committee for Space Data Systems (CCSDS) Reference Model for an Open Archival Information System (OAIS), subsequently adopted as an ISO standard (ISO 14721:2003).

Guiding principles were established that formalise the interactions between different

Figure 7. OAIS Functional Entities (from CCSDS OAIS Blue Book, January 2002).
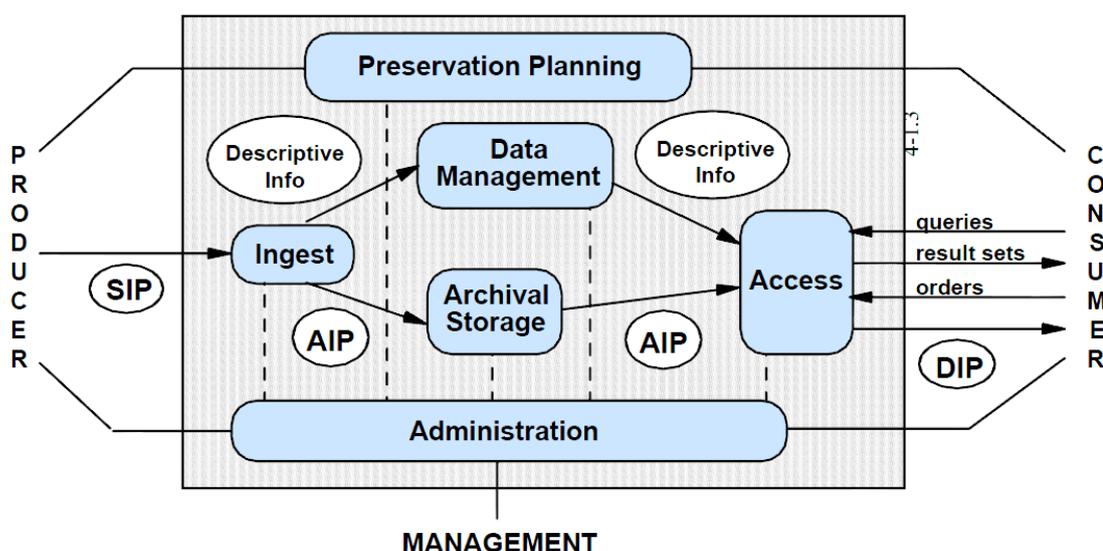
components of the archive and are OAIS compliant and is compartmentalised following the OAIS functional entities that are shown in the figure below:

The points of note are the following:
- The long-term preservation of data, including all information necessary for future use and interpretation of the data.
- Maintaining sufficient control of the data to ensure long-term preservation.
- Capability to retrieve requested data with neither loss nor distortion.
- Preservation planning for data migration without loss of data or interruption to current services. Planned data migration allows for intentional purging of data from archives.
- Separation of the processes of Ingest, Access, Data Management and Archival Storage.
- Specifically for space data, but relevant for other formats: Separation of reception dependent information implicitly encoded with the data on magnetic tapes. Such "de-spatialisation" of the data permits more flexible cataloguing and handling[149].
- In the space industry, cataloguing metadata is constructed according to ISO 19115.

The separation of the various processes gives the freedom to modify the underlying technologies and infrastructure whilst maintaining continuous levels of service. This allows scalability and performance to track requirements.

Separation of the index metadata from the actual data storage presents a second major advantage. Data may be distributed on other systems that are geographically dispersed and managed by different entities. Interoperability is

---

[149] Migration of SPOT data from linear tape to online and near-line storage allowed for significant reduction in preserved data. "De-spatialisation" and cataloguing allowed Earth observation images obscured by cloud clover to be discarded.

ensured by consistent definition of the interfaces between functional blocks. As an example, the CNES stores some 300TB of data collected from the SPOT program whilst an additional 700TB are stored at different locations worldwide and are included in the CNES catalogue.

4.2.4   The CNES STAF System

Developed in 2000 following the design principles described above, the STAF storage system is used in a multi-mission context and is designed to preserve the integrity of the stored data:

- There are always two copies of an archived file, stored in different physical locations and on different media technologies.
- Data files are stored in "collections", which are applicative logical views, and are not connected with the way the data are stored on the physical layers.
- Files are continually and automatically migrated from old storage media technologies to new technologies as recommended media lifetime is exceeded.
- An end-to-end integrity check is made using a data 'footprint' created from the file.

The STAF was upgraded to the latest technology generation in 2008, using the principles described above. The most recent architecture uses a combination of online disc storage for rapid access data caching and buffering, coupled with near-line and off-line tape cartridge storage accessible by a robotic media library.

Characteristics of the new STAF are:

- 16 million files in the archive.
- 600 TB of data (excluding copies)
- 3 TB of data archived per week with approximately 1 million new files per year.
- Data comes from dedicated missions such as satellites (telemetry, raw data, value added products), data from simulations and data from other experiments.
- Storage capacity is scalable from the current 1 PB up to 10PB.
- Data throughput is scalable depending on requirements. The current configuration responds to global user requirements whereby data is archived at twice the rate at which it is restored.
- The combination of online, near-line, and off-line storage provides energy savings over a completely online solution; tape cartridges that are not being accessed in the robotic media library do not consume any energy.

The benefits of preservation planning as described by the OAIS model are also apparent. Migration to the new STAF was approximately 200 times more efficient[150] than the early migration between tape formats.

The transversal nature of the system and organisation across multiple projects has several advantages:

- Projects with small budgets where the risk of data loss is high can make use of a highly reliable archive system.

- Investment costs are amortised across many projects.

---

[150] In terms of man-years per Gigabyte

A transversal structure encourages interoperability between missions. The open structure of the archive permits a large variety of different data types to be stored in the archive for multiple applications and clients as shown in the example figure below:
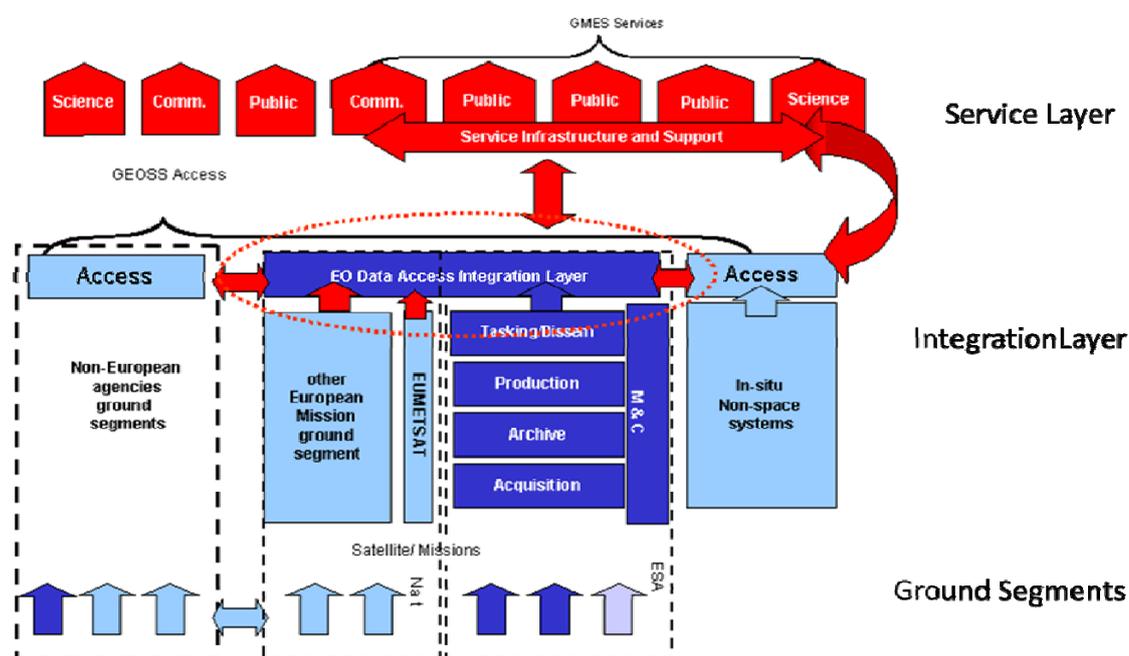
Figure 8. Extension of Storage System to Multiple Applications

The combination of the STAF archive and readily available catalogue of data renders the information stored in the STAF much more accessible to potential users.

The ease of accessibility provides the basis for new commercial and scientific applications exploiting the data held in the archive, aiding the speed of scientific advances and also generating revenue.

In relation to the Cinema industry, the Earth Observation system is highly centralised. This makes it easier for a process to ensure that newly acquired data passed through the 'Archive' step in its journey from 'Acquisition' to 'Access'. This may not be feasible, or at least harder to achieve, in the Cinema industry.

4.2.5   Example of Metadata Project: The CDPP Project and SERAD

An example of the cohabitation of different types of project and different types of data in a common archive is the CDPP (Centre de Données de la Physique des Plasmas) project, launched jointly between the CNES and CNRS in 1988. In the 1990's, awareness was raised of the interest of long-term scientific observations of plasma phenomena, and the requirements to store observation data lead to the creation of the project. The methodology has subsequently been extended to a total of 12 (completed or still running) scientific missions.

The objectives of the project were twofold:

- To store the data, for long-term use, using the STAF.

- To provide future access to the data and provide value added services.

The approach required the creation of a methodology allowing for long-term archival of data relating to the project. Project information to be archived could take various forms, not limited to spatial data, including for example, experimental data, graphical data and documentation.

Based on principles similar to the future OAIS, a methodology was created based on:

- The interface between the producer and the archive.
- The specifications of the data to be archived. Constraints and rules to be followed by the producer to ensure long-term exploitation of recovered data remain possible.
- Definition of associated metadata allowing archive data to be catalogued and accessed.

The SERAD (Service for Data Referencing and Archiving) project will provide the CNES with a centralised repository structure that collects, stores, and disseminates information and metadata on data that are under CNES responsibility. The objective for CNES is to better manage and improve the access to this data heritage.

In order to achieve this goal, it is mandatory to identify all data that are relevant and to verify that such data are properly archived; if not, then, to proceed with the archiving of these data.

The SERAD mission is then the following:

- To constitute and maintain an open and centralised metadata repository of all data under CNES responsibility.
- When necessary, to undertake the archiving of data.
- To survey the data production centres in order to guarantee the long-term preservation of these data even if, in the critical case, one of these centres has to be closed.

This system will be built upon existing generic tools that will be customised. The result is a process that can be generalised to other fields. Experience with such generalisation allows the definition and development of generic tools and the development of international standards.

Standards play an important role in ensuring interoperability between different functional layers in a system and between different systems. Open standards also ensure that information about how archives are structured and accessed is available over time. Members of the Consultative Committee for Space Data Systems have been active in the development of standards such as:

- OAIS (Open Archival Information Systems).
- PAIMAS (Producer Archive Interface Methodology Abstract) and its current implementation PAIS (Producer Archive Interface Specification – still under development).
- DEDSL (Data Entry Dictionary Specification Language, XML/DTD Syntax).
- XFDU (XML Formatted Data Unit).

The Long-term Data Preservation (LTDP) Working Group formed in 2007 with representatives of European Space bodies has the goal to define and promote LTDP Common Guidelines within all European Earth observation space data and archive holders as well as to increase awareness on LTDP.

4.2.6   Parallels with Preserving European Film Heritage

European Film Heritage shares many parallels with the space industry:

- Cinematic works and Earth observation data have an immediate value when created.
- The long-term value of both types of data is difficult to predict.
- Archives represent irreplaceable information and collections of scientific and cultural heritage.
- Evolution towards ease of accessibility generates new opportunities for commercial and scientific exploitation of data held in archives.

The amount of data is comparable in magnitude between the CNES STAF archive and a film archive collection. A collection of 5 000 full-length feature films digitised at 4K resolution[151] would occupy 25 PB of storage, a figure comparable with the European Space Agency's estimated archival requirements for 2020[152].

4.2.7   Towards a European Managed "Cloud" for Space Data Archival and Preservation?

Data archives with the type of open architecture and scalability as the CNES STAF and SERAD have potential to become specialised centres, operating as shared resources to offset infrastructure costs with geographical redundancy for data security and disaster prevention.

Customer service level agreements ensure that different applications would have the required level of service at the appropriate cost.

A common catalogue specification and standardised metadata would enable an archival system serving many different parts of European society.

4.2.8   Conclusions: Main Lessons

The amount of data created by Earth observation programmes is increasing. Aside from the immediate short-term value, such data is being recognised as having long-term value that can be exploited for scientific and commercial purposes. Ease of accessibility to archive data drives reuse and generates increased demand for new applications.

Long-term data preservation is crucial in many fields and has an impact on many activities in society. Initiatives in the Earth observation space segment may be applicable to other fields including the preservation of film heritage.

In order to benefit from commonality of systems and economies of scale, there is a strong need to have common, interoperable standards. Standards for interoperability are necessary between archive providers and users, and also for different elements of the archive such as metadata definitions, cataloguing and APIs between different system layers. Open and non-proprietary standards are strongly desirable in order to minimise the risk of data loss.

---

[151] 4096 x 2160 pixels, 48 bit precision per pixel, assumed 120 minute running time giving an approximate file size of 5TB with lossless compression of a factor of 2.
[152] European Framework for the long-term preservation of Earth Observation space Data, Long-term Data Preservation Workshop. Ref.: http://earth.esa.int/gscb/EuropeanLTDPFramework.pdf

A single data archive can manage multiple types of data and client if the archive is scaled appropriately and implements standardised cataloguing and metadata systems. A distributed European archive - an EU Cloud – operating under EU supervision with customer specific Service Level Agreements could address the archive requirements of multiple European activities.

> ### Application to the Film Heritage Sector – Lessons Learned
>
> - The CNES has been collecting and preserving data in digital format for more than 30 years from over 90 space missions, some of which are still active.
> - The CNES data archive holds many different types of data from diverse projects ranging from Earth Observation data to the results of particle physics experiments. Data in the archive have both a high cost of acquisition and commercial value for exploitation, analogous to that of FHIs.
> - A systems approach to the management of scalable data archives has been adopted, contributing to the development of the OAIS standard and practices. The complexity and dematerialisation of archives in digital form highlights the need for a rigorous systems approach to planning and migration if data integrity is to be assured. The OAIS approach adopted by the CNES, other space agencies, and libraries worldwide need to be embraced by FHIs. Collateral benefits would include the adoption of common terminology and approach with other industry segments facing similar challenges.
> - Format and support migrations occur on average once every 5 years. Risk and cost of migrations may be minimised with adequate advance planning. Advanced planning of these transitions is a major element of successful management of large heterogeneous data archives.
> - The space industry adopted a systems based approach out of experience and necessity, which now manages data in archives dispersed around the globe. A managed 'Cloud', operating at the European level, could address archive requirements for multiple European activities, and provide a means of bridging the skills gap within FHIs associated with the transition to digital.

5. Conclusions

5.1 Introduction

The following conclusions and proposals for recommendations are based on the analysis of the data, the content of the interviews and the replies to the Survey distributed by the study.

It is of major importance to highlight that the number of possible Recommendations is extremely high, depending on the depth and the level of detail they want to reach, as the topic is quite vast and it covers deep changes and re-organisation in most if not all activities of all FHIs across Europe.

The authors of the study opted for a reasonably limited, albeit comprehensive amount of basic and concrete proposals for action in order to start the process of reacting to the changing environment as soon as possible, as most of the changes that are discussed in this study are already ongoing, and actions are extremely urgent.

5.2 Film Heritage and Film Heritage Institutions

With a history dating back to the 1930s, the hundreds of European FHIs are the guardians of most of the European Film Heritage, a key to the history and culture of Europe from the late 19th century.

FHIs differ in size, mandate, legal statute, and resources, but they all share key activities: collect, preserve, restore, provide access, which they carried out for many decades.

FHIs played and continue playing a key role in supporting the film industry in areas or at times when the industry is not interested in, or capable of, investing. This is the case with conservation and preservation, a service FHIs provided over decades when cinema works bore no commercial value, and with restoration, with most European films being restored thanks to, or in collaboration with the FHIs.

Saying that all cinema works that were saved from oblivion and now find their way to new distribution channels were saved by FHIs is not far from the truth.

European FHIs also hold a unique wealth of competence and skills in the preservation and restoration of cinema.

The FHIs have a long history of providing access to their collections, in theatres across all of Europe. Whole generations of filmmakers were formed in those theatres.

The study moves its analysis and its recommendations on the assumption that *cinema is worth preserving for the future, and it is worth being given access to* for cultural or educational uses, for commercial purposes, for pleasure, or to allow European citizens to know their own history and culture.

This is based on a vast body of National laws as well as documents, recommendations and directives at European level

Another clear indicator that cinema is defined as a key component of all Member States' culture is the fact that cinema industry is supported to a significant extent by public funding.

State aid to film industry is calculated at 1.6B€ / year in direct aid, plus 1B€ / yr in tax incentives. Cinema is an important investment for MS.

5.3 A new Landscape: Cinema is Digital

Cinema is Digital now.

The transition to Digital projection in theatres is well under way across Europe and experts expect it to be basically completed by mid-2012 in the major European markets. While until months ago only some films were distributed *also* for digital projection, now almost all movies are distributed on film and on digital, and some are distributed *only* digitally. This is often the case for independent, low budget productions.

Cinema post-production has been digital for many years now (the first movie completely post-produced digitally dates from 1997), and digital capture (shooting on digital rather than on film) is increasing at a very fast pace that is expected to accelerate as soon as distribution is completely digital.

The impact of these changes is deep on the whole cinema industry; the sectors of cinema production and postproduction already show signs of undergoing a restructuring phase and this is expected to intensify in the coming months. This dynamic is not the object of this study, and it will be discussed only in the aspects affecting cinema preservation. It is worth noting that this phenomenon does not receive the attention that it deserves for its industrial and commercial implications.

The combined impact of distribution and exhibition 'going fully digital' from capture to projection will inevitably lead to the disappearance of the whole sector of analogue film technology: film equipment (printers, processing machines, etc.) as well as film stock productions are expected to basically disappear. With the industry, also the know-how, competences and skills related to analogue film will sooner　　　　　or　　　　　later　　　　　disappear.
The actual timing of this phenomenon is hard to define and might take years, but it is inevitable.

The whole process of standardizing D-Cinema technology is currently well underway at SMPTE (Society of Motion Picture and Television Engineers) and at ISO (International Standardization Organisation).

As any standard used in a professional context where important changes in the specifications might result in high costs of adapting (i.e. need to purchase new projection equipment), D-Cinema standards for exhibition (DCP) are expected to be relatively stable over time.

Nevertheless, **it is not realistic to expect that the rapid advances in IT** (ever increasing computing power and bandwidth available for distribution, and decreasing storage costs) **will not have an impact on D-Cinema standards over the medium term**. In other words, it is realistic to expect that D-Cinema standards will change in the next couple of decades.

This will become a critical factor in ensuring the preservation of D-Cinema content in the medium-long term, and FHIs must be have the resources to deal with these challenges.

The actual materials, elements, formats that are the result of a contemporary cinema production process or of a digitisation or digital restoration process reach a FHI can differ deeply. The lack of proper description and of standards for the technical description of digital images formats and deliverables is considered an extremely serious problem by archivists of private and public FHIs. Efforts should be directed to this problem in the short term.

5.4 Collections

Obviously, **there is no preservation without acquisition**.

FHIs are not fully equipped in order to correctly acquire cinema content in a digital form.

It has been noted that for a FHIs to process correctly a digital element at ingest (i.e. at the moment of the deposit) a FHIs must:

- Receive in deposit materials that the FHIs can check, i.e. that are not encrypted; if encrypted, a key that allows to completely de-crypt the content (the so-called Distribution key or Studio Key) is to be delivered
- Have adopted a comprehensive metadata schema allowing to record the technical characteristics of the digital object (at ingest and all along its life cycle, including at migrations)
- Have acquired the proper hardware / software tools necessary to inspect, analyse, check the digital objects at ingest and all along its life-cycle
- Have the necessary know-how within its staff to apply the above to the many digital formats that are being, will be, or might be ingested

These conditions are met by few European FHIs in the commercial or in the public sector. The main reasons are

- the lack of standards to correctly describe the technical characteristics of the content being deposited that is necessary in order to be able to preserve and reproduce correctly the material in the future,
- the lack of staff with the necessary skills and competence,
- the lack of resources to fund the acquisition of the necessary technologies (hardware and software) to perform even the simplest checks on the ingested materials.

A similar situation exists in the US, but it must notice that producers (mostly the Hollywood studios) are quite active in researching solutions and best practices for acquiring and preserving digital cinema content. **The European film industry appears to be also ill-equipped to face the challenge of Digital Preservation.**

No need to say that budget-wise, the situation in the US industry is quite different from the one in Europe. Also, the relatively small average size of the European production companies and the fragmentation of the market are sources of concern regarding the capacity of the industry to effectively preserve its own products.

Acquisition of digital content into the collections of FHIs is as problematic as critical. Too often digital elements and masters are left in deposit with post-houses and D-Cinema service providers. With a significant restructuring of the sector underway, this is a serious risk.

Public, non-profit FHIs via the Technical Commission of the International Federation of Film Archives (FIAF) produced a first set of Recommendations concerning viable formats for the (legal, contractual or voluntary) deposit of D-Cinema materials. This is a first step in the right direction, but only the first of many that are needed. The Recommendations highlight how encryption is a serious threat to preservation, and that only un-encrypted content can be the object of a serious preservation activity.

The FIAF TC Recommendations are fairly recent and they are still to be applied systematically. Although critical for the preservation of D-Cinema content, this is expected to be difficult as a significant resistance to deposit unencrypted content is generally found with depositors. Wherever the legislation allows the FHIs to indicate the acceptable formats for mandatory deposit this might be possible; but the application of these Recommendations is unlikely at best in the case of voluntary deposits.

Voluntary deposit plays a significant role for European FHIs to acquire cinema content from producers, distributors and service providers; the continuation of this practice is not guaranteed when cinema distribution will be only digital. **On the contrary it is highly probable that voluntary deposit will virtually disappear with the complete dematerialization of cinema content**, particularly when this will be delivered via digital channels and not by physical carriers (hard disks, as it is largely the case now). **Voluntary deposit**, **including for non-European productions**, **needs to be proactively sought for and encouraged**.

Obviously, the main reason why depositors resist the concept of depositing unencrypted formats is security. **FHIs must be ready to take all needed precautions and technical solutions to make digital deposits secure**.

Norms prescribing the deposit of cinema materials in a 'national archive' (here definitions differ, of course) exist in most European countries, although they differ quite significantly from country to country. In some cases this is limited to productions supported by public funding. In others they refer to 'national productions' (under differing definitions), or to all cinema content distributed in the country.

In almost all cases these norms will require some adaptations due to the advent of Digital distribution; these might be minor or significant depending on the wording of the norms.

It is important to notice that in the digital domain, the costs that the depositor must bear in order to deposit of digital masters or DCPs are so

small that they are completely irrelevant. In the analogue domain a distribution print would have cost some thousand euros, an inter-negative around €25,000, while a digital file can be transferred with zero cost.

For all these reasons, although deposit of digital content takes place in most of not all major European archives, the quantity is still limited. This is expected to change dramatically already in the coming months. Ideally, at the end of the process European FHIs should deal with masters for some 1100 feature films every year (the figure corresponds to European feature films produced in 2009). This will be result in a significant workload and costs.

5.5 Storage and Long-term Preservation

The dematerialization of cinema content will have a profound impact on the way in which existing and new material is preserved, both for conservation and for access. The completion of the transition to digital for production and exhibition has potential to trigger a number of events that directly impact the preservation of cinema heritage:

- Analogue film prints become generally unavailable and most new works exist only in digital form.
- The creation of an analogue film print for preservation is no longer an incremental cost on the back of a distribution print run.
- The long-term future of 35mm film stock becomes uncertain. Volumes will decrease, costs will increase, and there is no guarantee of continued availability of types of film stock and processes at the current standard of quality.
- The collapse of the 35mm film value chain will adversely impact availability and developments of equipment for the creation and reading of 35mm film.

At proper conditions, analogue films can be conserved virtually forever, up to 500 or 2000 years depending on their support and conditions. **Overall costs of analogue film preservation are reasonable compared to higher costs for Digital Preservation**.

Long-term Preservation of analogue film elements is therefore not problematic nor particularly costly, **but this is largely limited to non-circulating masters**.

On the other hand, the preservation of digital works, either born digital or digitised, is at a very early stage of maturity by comparison to film. There is no experience with managing collections that are purely digital over the same timeframe as cinematic archives, yet the pace and economics of the transition to digital oblige solutions to be found or to risk irrevocable loss of digital film heritage.

Successful digital preservation requires a systematic approach to be adopted, regardless of the physical form of the archive to be managed. Policies and systems for the management and preservation of physical collections are well established.

In order to ensure Long-term Digital Preservation (LTDP), a digital repository must perform media migration and format migration

Media migration is the process transferring the unchanged bit content from one support or storage technology to the next (e.g. from an LTO3 to and LTO4) in order to overcome and meet:

- Media decay.
- Media obsolescence.
- Increased cost effectiveness.
- New consumer service requirements

Format Migration on the contrary implies the transformation of the content from one format to another in a way that maintains the functionality of the content (e.g. as re-formatting a WordPerfect file into Microsoft Word). Format migration implies an irreversible transformation of content representation, either analogue or digital. Reasons that make a format migration necessary are usually connected with the unavailability or obsolescence of the original software that could 'read' the content.

For an archive, format migration presents a greater risk to the preservation of film heritage than media migration, as the content undergoes a transformation. Also, technical metadata fully describing the original format are critical to the success of the procedure.

Choice of data formats is also critical for LTDP, as all proprietary formats are to be avoided (as they could be discontinued without notice, plus they are usually not fully disclosed) in favour of open source or open standards, and all sort of encryption should also be avoided as it hinders the possibility not only of format migration, but also does not allow one to check the integrity of the content (e.g. after media migration).

A combination of media and format migrations are expected to take place every 5 to 7 years.

Content for LTDP should be stored in an uncompressed or to least losslessly compressed way. This increases the storage costs but it is vital for LTDP.

5.6 The costs of Digitisation and Long-term Digital Preservation – some projections

The Quantity of cinema materials requiring digitisation in Europe is calculated in **1M hours**. This figure calculated as 'worst possible scenario'.

The cost model adopted for digitisation projects show that per-hour costs range between €**500 and €2,000**. **This translates in a cost to digitise the whole European cinema heritage between €500M and €2B**.

€2B correspond to approximately 75% of the aid that Members States invest in the cinema industry in one year

Based on a projection of 1100 feature films and 1400 short films produced every year, the amount of data can be calculated between 5.8 and 30PB/year. 5.8PB will be taken as reference in the study.

The cost of depositing a digital master in FHIs is virtually zero.

According to the study's cost model, preserving the new cinema digital productions in a digital repositories, **would cost €5M/year**

Even by multiplying this by a factor or 4 to allow for FHIs to get equipped, the cost would still be only 0.77% of what the MS invest supporting cinema.

If the whole European Film Heritage is digitised, this is projected to **amount to 1,900PB.**

The result is an overall cost of **€290M per year.**

These costs and investments must be ADDED to the current budgets of the FHIs, as the care of digital works does not REPLACE the care of analogue collections, but it is added to it.

A lack of action would result in

> **- a loss of newly produced films due to lack of serious long-term preservation**

> **- the non-availability of any film that is not digitised**

These two factors will negatively impact European competiveness in several fields, such as VoD, home video distribution, TV market,

Projections for loss of new productions are calculated at 220 feature films in 2016 and 330 in 2017 and onwards.

Public funds invested in these works are calculated to €580M to €780M per year

The cultural impact of the complete disappearance of European film heritage is also a serious concern, as higher education in anything media-related will be impossible, not to mention how cinema content can and does contribute to the study and understanding of European history, culture, and identity.

5.7 Digital Restoration

According to most stakeholders, digital restoration can be considered a 'mature field', with few specialised software solutions available to correct damages and flaws in image and sound. Very little R&D seems to be ongoing, compared to some 10-15 years ago.

Experts do not expect dramatic improvement in the performances of digital restoration software, beyond the increase in speed due to improved computing power.

Costs are rapidly decreasing in terms of hardware / software.

Costs are still high because of the incidence of manpower to perform tasks that cannot be automated. Experts are sceptical that new research might make the software fully automatic, or significantly decrease manual labour.

Some archivists and service providers indicated that scanners should be made more capable of dealing with often fragile and damaged archival films.

On the other hand, many expressed the concern that as soon as cinema capture turns completely digital (i.e. there is no more 'shoot on film'), the scanner industry is bound to disappear. Already now, there seem to be scanning overcapacity in Europe, at least in the sector of new productions.

If this forecast is true, it is important that digitisation projects take place before scanning equipment become rare and expensive to maintain, and the service provider's sector moves away from scanning.

5.8 Access to Film Heritage

Most FHIs are engaged in some sort of digitisation activity, although the scale and scope of such activities differ from one FHI to another.

According to the results of the surveys, most FHIs provide most digital access services to two categories of users: researchers and scholars on one hand and broadcasters on the other, with the general public being largely served by theatrical projections or by DVD distribution (for the many FHIs that have one).

Digital access for researchers means onsite viewing, and in the case of broadcasters this usually takes place after agreement of the rights-holders and via some form of digital file or DVD.

'Out-of-premises', remote access is generally limited to loans (provided that rights are cleared) and eventually to distribution of DVDs produced directly by the FHIs.

The examples of online access are so limited in scope and in size, or so recently started that they hardly make up significant examples and case studies.

As we pointed out earlier, the real question is why FHIs do not make their digitised collections available to a wider public, and why digital access is basically limited to the industry and to onsite researchers.

FHIs indicate that a limiting factor to provide wider access (for example via Europeana) to their collections is the complexity and the resources required in identifying and locating the rights-holders for large parts of their holdings (e.g. older works, documentaries, factual footage).

This complexity (that is also claimed by others, such as the public broadcasters) translates into costs and longer times, and this hinders both the cultural, non-commercial, and the commercial access to the collections. On a systemic level, this is considered a serious source of inefficiency and a competitive disadvantage (e.g. in sectors such as VoD and re-use for new productions of archival footage).

Recent EU initiatives to address the issue of 'Orphan works' is aimed at reducing this complexity, as do other models, such as the Extended Collective Licensing model.

Successful digitisation projects are based on some sort of framework agreement or model involving a positive collaboration with the rights-

holders, and this seems to prove the point that a reduction in the complexity of IPR management is a necessary condition, independently of the chosen model.

It is also important that actions are taken in order to avoid that the same complexity is reproduced in the future.

Limitations in budgetary resources impact both the actual digitisation process, as well as the whole pre-digitisation work required, which includes selection, design of delivery strategies, technical solution and IPR management.

Concerning a comparison with the situation in the US, it is worth noting that in North America FHIs face a simpler situation in providing access to at least a significant part of film history (all works pre-1923 are Public Domain, exceptions are foreseen in the law to help access of older and non commercially available works). This, added to the less fragmented market and industry, gives the US a competitive advantage.

An analysis of the requests for access, the archival DVD sales, and other mixed data, seem to indicate that when offered, the public is interested both in the narrative feature film as well as in 'other materials', as documentaries, newsreels, factual, animation, commercials, amateur films, etc. In other words also parts of film history that are considered 'minor' are in some level of request from the general public. A similar trend is also to be noticed in 'professional' access from researchers and scholars and from broadcasters, with both these groups expanding their interests beyond the traditional concept of 'film content'.

5.9 Film Heritage and Europeana

There are hardly any FHIs in the public sector that is not supportive of the idea of general access to at least parts of its collections, **for educational and cultural uses**. Also, they Europeana as an unprecedented opportunity to not only give access to its collections, but to be able to contextualise them with other types of documents and collections.

Limiting factors to providing more cinema content to Europeana are similar to those discussed in the previous paragraph about Access. It is worth noting that 'free-to-re-use-for-all' metadata is considered a problem for some FHIs, and that the concept of 'free access' might be a limiting factor to agreements with rights holders.

After projects such as European Film Gateway[153], technical issue does not seem to be of significant concern for FHIs to provide content to Europeana.

5.10 Digital Cinema and Film Heritage

The DCI specifications were made for the distribution and exhibition of commercial theatrical feature films. Consequently the needs of archival films but also of those that were produced for TV were not considered in the original version. **Recent**

---

[153] http://www.europeanfilmgateway.eu/

additions introduced in the standards (e.g. about frame rate) overcome the most relevant limitations to the use of D-Cinema for archival content.

The average cost for a digital 2k projector and server installation made for smaller screens (10m to 15m) can be currently seen at around €70K.

Most FHIs that have a regular programming of films often show more recent films, or titles coming from distributors, so FHIs are undergoing a progressive digitisation of their theatres.

FHIs can also take advantage of the reduced costs of distributing D-Cinema as compared to analogue cinema: While analogue cinema distribution costs for an archival title are at reasonably between €15K and €20K, costs for digital distribution can be as low as few thousand Euro.

This offers enhanced opportunities for a more effective and efficient distribution for archival content via D-Cinema projection, both in a commercial or in a FHIs' environment. Availability of archival content has always been considered a bonus to help the differentiation of theatres' programming, and one of the many advantages of the digitisation of theatres across Europe.

6. Proposals for action

6.1 General principles

All parties concerned must act immediately, as the technical and structural changes in the cinema environment are profound and well under way. These changes challenge the whole life-cycle of cinema works and the traditional activities of the European FHIs to the extent that both the preservation of the cinema of the future, and the accessibility to the whole European film heritage is at risk.

The principles that should guide these actions are clearly defined in the many EU documents regarding film heritage and its preservation, and in particular in the "Council Resolution of 26 June 2000 on the conservation and enhancement of European cinema heritage, and the "Recommendation of the European Parliament and of the Council of 16 November 2005 on film heritage and the competitiveness of related industrial activities".

The basic principles contained in these official documents constitute a sufficient basis for the actions that are required. Furthermore, the recommendations and resolutions contained in these documents should be implemented with the shortest possible delay and with the utmost decision and energy.

All parties concerned, the EU institutions, the Member States, the FHIs and the cinema industry must recognise the urgency of taking actions

- **positively engage themselves in solving the issues endangering the preservation and future accessibility of European and national cinema**
- **create the conditions by which precise and detailed plans are defined at national level with the involvement of all FHIs and of the principal stakeholders**
- **recognise that the depth of the changes in the field is such that extraordinary measures must be taken if the European cinema of the past and of the future is to be preserved.**
- **MS should engage themselves in providing steady and continuous support for the FHIs in both preservation and access via mass digitisation of cinema content to avoid its becoming inaccessible in a digital world.**
- **Digitisation and Digital Preservation entail a complete redefinition of traditional archival practises, such as ingest, viewing, quality control, checking, which must all be redesigned for digital content. The FHIs should also be supported adequately to acquire the necessary equipment**
- **MS, eventually with the support of the appropriate EU programmes, should support the re-training of FHIs staff to acquire the necessary skills**

- **MS should encourage a structured and institutionalised education and training for personnel working in FHIs and other heritage institutions. According to the Second Implementation Report Europe is lagging behind in terms of higher education for moving image archiving**

The issues discussed in this study are not stabilised and are evolving very fast. **It is therefore advisable that such an analysis of the overall situation and of the advances in the different MS and FHIs is performed on a regular basis, for example every two or three years.**

The answers to the challenges, and the best ways to seize the opportunities offered by the advent of digital are to be found via the closest and most effective inter-European collaboration.

The FHIs, with the support of the Members States and the Commission should immediately establish an effective network to address the issues raised in this study, to share experiences and competences, and to plan for common actions.

6.2 Collection

FHIs are not equipped to deal with the ingest of new works that are entirely produced digitally: they lack the internal expertise, the equipment and the staff to perform these tasks.

This translates into a serious danger for the conservation itself of European cinema.

As the activity of preserving current digital productions does not replace the conservation of the analogue collections, but it adds to it, and in consideration that a whole new set of skills, equipment and qualified staff needs to be acquired by all FHIs, it is important to recognise that this inevitably must translate in a significant increase in the FHIs' budgets to allow the transition. Obviously, the exact extent of the budgetary increase cannot be defined by this study for each institution, but it is liable to be significant.

MS should support the FHIs with significant increases in their budgetary resources in order for them to acquire the necessary equipment, staff and competences.

FHIs must as soon as possible act by defining detailed plans for their actual needs in the short and medium term (i.e. from the next fiscal year to the next three years).

As most FHIs lack even the expertise to draw up such plans, the Commission might help in searching for possible instruments to facilitate this phase, for example, by facilitating the circulation of competences, or by supporting the definition of *best practices* and *guidelines* for actions to be adopted by the FHIs.

As they were calculated by this study, the cost of introducing contractual or legal deposit across Europe for digitally produced works is not excessively high. Most specifically, the costs for the industry are virtually nonexistent, while the costs for the FHIs and the Member States are reasonably low, for example in relation to the levels of public aid to the cinema industry.

The study also confirmed the absolute need to reinforce the mechanisms of compulsory deposit, and, lacking this, of contractual deposit for at least all films having received public funding.

The Commission should reconfirm, and stress the necessity of introducing and reinforcing mechanisms for the structural collection of cinema works, produced and distributed analogically or digitally.

MS with the input of the FHIs should review the existing laws and regulations concerning the mechanisms in place in their legislation in order to make sure that:

- **all works that should be deposited are actually deposited, and**
- **this happens in the proper formats and at the time of distribution.**

For the time being the formats required are those specified by the Technical Commission of the International Federation of Film Archives: DCDM or unencrypted DCP.

Legislation should be formulated so that the FHIs or the FHIs in charge of the deposit can define the appropriate formats without having to re-write the law.

The law and regulations must also clearly define that the guiding principles are that what is deposited is appropriate for long-term preservation, and it is deposited as soon as the work is finished, for example at the moment of the first distribution.

These two actions should be taken as soon as possible, ideally within 12 months from the publication of this study

FHIs should immediately start planning for the best ways to design and implement a digital repository for long-term digital preservation of digitally produced and /or distributed cinema works. Such a repository should meet the requirements of the ISO standard "OAIS – Reference Model for an Open Archival Information System".

The repository must also be designed to provide the maximum possible levels of security and control to avoid any risk of piracy, while maintaining unencrypted materials.

Such repository(-ies) should be in place not later than December 2012. In the transitional period, FHIs should make up plans to allow for the secure and safe safeguard and preservation of digital content in a

"transitional repository" that might not fully comply with the OAIS Model.

MS should support this planning stage with the necessary funding.

The ACE (Association des Cinémathèques Européennes) and the European FHIs, duly supported by the MS, and possibly with the help of the Commission, should collaborate as closely as possible so that the characteristics and the specifications of such repositories are defined jointly by pooling together the competences and the expertise present in the different FHIs across Europe.

To this end, the ACE should consider the creation and the coordination of a Group of experts drawn from within the FHIs, but also with the contribution of external experts to support this endeavour. Such an Expert Group should later become permanent, and be responsible for a continuous study of technical and organizational issues, and be required to produce research, analysis, and recommendations on issue such as preservation techniques, and technologies, procedures, and metadata. A Sub-group could also be responsible for dealing with digitisation issues.

In time, it could be advisable that such an Advisory committee or group has a precise legal status allowing a real supervision of the cooperation and coordination of initiatives at EU level, at least in an advisory role.

The above mentioned FHIs Advisory Group should also be charged with the discussion of the opportunity of the introduction of an EU standard for the deposit and submission of digital cinema content to FHIs for long-term preservation.

Such a standard should be open, well described, allow to be used for a wide range of materials, including potentially video and TV-originated, allow different resolutions, qualities, etc.

It is more likely to be a target format that is used within the archive, rather than something that the industry provides.

Research on the topic should be done first, before going for a new standard. ICT would be the right place. It is also to be understood that such research must be focused on cinema as well, not just on TV as until now.

As it is expected that analogue collections will become more long-term preservation-oriented as analogue materials will not be less used for access purposes, MS should make sure that FHIs are properly equipped for the long-term preservation of analogue materials in the best possible conditions of conservation as defined by the most recent body of research. As a matter of fact not all European FHIs have the necessary resources, or are not equipped for such strict conditions of conservation.

The Commission should call the MS to support the FHIs adequately to this end.

The Commission should reaffirm the principle that MS must implement legislation allowing FHIs to undertake all necessary technical processes to ensure the long-term preservation of cinema content.

Appropriate exceptions to existing copyright laws must be introduced that broaden the spectrum of possible activities so that no possible misinterpretation is possible. For example, the simple concept of 'copying for preservation' although it is a good basis, must be tested against all possible necessary processes, which might include media and format migration transmission to one or more remote locations for preservation purposes, etc.

The Commission and the MS should consider to effectively encouraging the voluntary deposit of non-national works, or of all works that are not funded (for the MS where deposit is mandatory only for publicly funded films). There is a serious danger that from 2012 / 2013 only national productions will be deposited in FHIs, thus seriously under-representing the cinema culture of all MS that is largely influenced by works from non-European countries. MS could for example consider some forms of economic incentives to encourage voluntary deposits, although it is clear that the best incentive will be the availability of a trusted repository for long-term digital preservation as previously described.

6.3 Preservation

One lesson to be learnt from other fields is that LTDP is possible, it is done everyday everywhere, for large amounts of data, and for high security data as well, that transitioning to digital requires funds and a capacity to plan ahead and engage in strategic planning, all things that FHIs are not so used to doing anymore as the technology they are using has been stable for too long, and because they simply lack the manpower and the funds. Solutions exist in areas that are close to FHIs, as broadcast, space and health data, etc.

Effective and efficient systems cannot be improvised, they require time and effort to be properly designed, implemented and tested. Metadata is key

Work must be considered ongoing, not a 'one-shot'

The following recommendations are part of the planning that the FHIs should undertake, and of the research that the EU should encourage and support:

- **The provision of adequate and continued funding to maintain digital archives**
- **Works produced digitally must be preserved digitally**
- **Continue to build on best practices developed in adjacent industry segments.**
- **At a European level, ensure a minimum level of interoperability for the access to catalogue information and content.**
- **Data formats used for archive content should be standardised and open.**
- **Content encryption increases the risk of data loss. Unencrypted storage should be favoured over encrypted storage, with content security provided by other means.**
- **Content should not be stored in encrypted form**
- **Archival content may be stored using lossless compression.**
- **Lossless coding schemes should be optimised for simplicity and robustness rather than absolute compression efficiency.**
- **Digital formats are to be preferred for born-digital works in order to preserve work in its entirety.**
- **Maintaining the current national structure of FHIs will continue to enable Member States' access to existing photochemical based film heritage.**

Long-term Digital Preservation (LTDP) systems are usually large and expensive at the moment, and they are not necessarily well tailored to the needs of cinema content (such as many very large files, or a very high number of average –sized files, constraints in terms of read/write speed, bandwidth, Quality of Service if 'real-time' is required, possibility of working with many formats both at ingest and output, etc.).

A real advantage in terms of economy of scale across the EU would be a serious impulse to define a common digital cinema collection management system whose core engine is open source and made available to all institutions. R&D is needed, and also a realistic business model that makes such an application both affordable and sustainable (upgrades, etc.). This could be an area for research to be carried out at EU level.

Similarly to the example of the CEN standard for filmographic terms, the FHIs should work on the definition of metadata standards for the long-term preservation of born digital or digitised moving images and related sounds. Schemata for such technical, administrative and preservation metadata do not exist, and plus they would require to be adapted to Europe, for example in terms of multilingualism.

The hypothesis of large, transnational repositories operating at European level, perhaps under the umbrella of Europeana is worth studying and possibly experimenting, as it could be a solution to encourage voluntary deposit for non-European works that could be deposited in such a structure without having to be deposited 27 times. Having said that, at the moment the experience in the FHIs and in other fields is too limited, besides, the concerns about security and the

fragmentation of the European cinema market make it improbable that such a solution can be promoted just yet. This is rather a perspective in the medium to long term. A possibility would be that an appropriate research project on such an issue was introduced, either at National, or, more appropriately, at EU level.

6.4 Restoration

Research in the field of Digital Restoration should be encouraged, at EU or MS level. In particular, further development in scanning technologies specifically adapted to archival films would be welcome.

6.5 Access & Europeana,

The Commission should reaffirm and reinforce the recommendation for the MS to define and implement large digitisation programs, similar (in scope, if not in application) to the Dutch project 'Images for the future'.

It is also vital that MS recognise that digitisation should happen in the short term or the risk is that technology and expertise for digitising large collections of analogue film materials are lost.

As the study highlights, the window of opportunity for such mass digitisation projects is already closing, and it is not realistic to assume that it will last more than 7-10 years.

Such projects should be vast, covering possibly the whole national production, with equal attention to fiction and non-fiction (which has a remarkable commercial value).

Clear and strong collaborations with the rights holders are needed. It is highly probable that this collaboration will be gained in exchange for public funding to support digitisation, as most rights-holders are not ready – technically and financially – to undertake such massive digitisation projects.

Once such mass digitisation projects are in place, the problem of material for Europeana will be solved. It must be clear that the very first reason for the lack of cinema material to be made available in Europeana is the lack of funding. Apart from the projects in the Netherlands and some initiatives such as those in Norway and the one being planned in Finland and France, MS have not invested new resources for the digitisation of the cinema heritage.

It must be also very clear that the lack of appropriate funding lies behind the rights issue. Lack of funding implies that the FHIs simply lack the

manpower to carry out the necessary research on the rights; in addition, the availability of funding would make it possible for the FHIs or the MS to set up business models and engage in negotiations with the rights-holders. Projects such as 'Images of the Future' show that they can be successful as long as the public sector comes in with resources and long-term commitment.

6.6 Training and Education

Training is of course necessary at two levels.

First, part of the FHIs existing staff needs some level of re-training to be able to handle the new tasks required. It is necessary that FHIs engage in this activity as soon as possible, by identifying the staff that requires re-training (and is willing to do so), precisely defining their training needs and organizing the training events.

Costs for this type of training could be significantly reduced if training was to be designed at transnational level, either in language areas, or at EU level. Training materials could be produced and effectively used across institutions. This would also have the advantage of fostering the exchange among FHIs, and disseminating the knowledge of existing best practices and standards.

Secondly, it is recommended that institutionalised, structured training and education is organised across the EU, at universities or at university-level institutions.

At present, as it was highlighted during the conference on archival education and training organised within the Spanish Presidency, and as it is reported in the Second Implementation Report, there are fairly few opportunities in this field across Europe. Obviously, digital preservation of cinema content is and will always be a specialised field requiring a relatively small number of trainees per year across Europe, but it is also true that most of the topics that such courses should cover are common to other fields with larger requirements in terms of workforce, such as the audiovisual and media industry in general.

It is time that Digital Preservation and possibly Digitisation of analogue artefacts in archives, libraries and museums become a topic for higher education across Europe.

FHIs should collaborate as much as possible with such initiatives, and in general, FHIs should implement policies that encourage such endeavours, for example by define hiring policies that strongly encourage the hiring of qualified staff against the ongoing practice of in-house training.

In-house training's effectiveness is proportional to the skills and competences that are present in the institution. This means that FHIs are ill-equipped to proceed to in-house training in new areas such as digital preservation and digitisation that they do not really master, and

furthermore, this tends to be a challenge for smaller and younger institutions who lack internal resources or highly qualified staff.

Finally, it is of the utmost importance that such programs and courses keep teaching analogue archiving practices and technologies. In fact, analogue collections will continue to exist within large institutions such as museums, libraries, archives, FHIs, etc. and even more critically, younger generations willing to enter this profession will be less and less exposed to analogue technologies. How many 15-25 new employees in an archive have a significant experience of analogue media – discs, films, analogue audio or video tapes?

7. Appendix

7.1 Appendix 1 - List of abbreviations

2k	Horizontal resolution of 2048 vertical lines
3D	Three dimensional representation
4k	Horizontal resolution of 4096 vertical lines
AB	Advisory Board
ACE	Association of the European Archives
AES	Advanced Encryption Standard
AMIA	Association of Moving Image Archivists
AMPAS	Academy of Motion Picture Arts and Sciences
BS	British Standard
CASPAR	Cultural, Artistic and Scientific knowledge for Preservation, Access and Retrieval
CCSDS	Consultative Committee for Space Data Systems
CD-R	Compact Disc-Recordable
CD-ROM	Compact Disc Read-only memory
CDPP	Centre de Données de la Physique des Plasmas (Data Center of Plasma Physics)
CEN	European Committee for Standardization
CNC	Centre National de la Cinématographie (National Centre of Cinematography, France)
CNES	Centre National d'Etudes Spatiales (National Centre of Spatial Studies, France)
D-Cinema	Digital cinema
DAE	Digital Agenda for Europe
DAEFH	Digital Agenda for European Film Heritage
DCDM	Digital Cinema Distribution Master
DCI	Digital Cinema Initiatives
DCP	Digital Cinema Package
DEDSL	Data Entry Dictionary Specification Language, XML/DTD Syntax
DPX	Digital Picture eXchange
DSM	Digital Source Master
DTS	Audio System
DVD	Digital Versatile Disc
EAC	Education and Culture Directorate General
EBU	European Broadcasting Union
ECL	Extended Collective Licensing
EDCINE	Enhanced Digital Cinema
EFAD	European Film Agency Directors
EFG	European FilmGateway
ERA	Entertainment Retailers Association
EU	European Union
EUROVoD	European Video on Demand
FAOL	Film Archives Training OnLine
FHIs	Film Heritage Institutions
FIAF	International Federation of Film Archives
FIAPF	International Federation of Film Producers Association
FIAT	International Federation of TV Archives
FICAM	Fédération des Industries du Cinéma, de l'Audiovisuel et du Multimédia (Federation of Cinema and Audiovisual Industries)
FIRST	Film Restoration and Conservation Strategies,
fps	Frames per second
GB	Gigabyte
GDP	Gross Domestic Product
HD	High-Definition
IASA	International Association of Sound and Audiovisual Archives
IIF	Image Interchange Framework
IMAGO	European Federation of Cinematographers
IMCA	International Media Consultants Associés

IMF	Interoperable Master Format
INA	Institut National de l'Audiovisuel (Audiovisual National Institute)
INFSO	Information and Society Directorate General
IPR University Center	Immateriaalioikeusinstituutti (Intellectual Property Rights Institute)
IPTV	Internet Protocol Television
ISO	International Organisation for Standardisation
ISO/IEC	ISO Information Security Standard
IT	Information Technology
JPEG	Joint Photographic Experts Group
KAVA	Kansallinen audiovisuaalinen arkisto (National Audiovisual Archive, Finland)
KDM	Key Delivery Message
LE	Life Expectancy
LOCKSS	Lots Of Copies Keeps Stuff Safe
LTDP	Long-term Digital Preservation
LTO	Linear Tape Open
MIDAS	Moving Image Database for Access and Re-use of European Film Collections
MPAA	Motion Picture Association of America
MPEG	Moving Picture Experts Group
MS	Member States
NARA	National Archives and Records Administration (USA)
NDIIPP	National Digital Information Infrastructure and Preservation Program
OAIS	Open Archival Information Systems
P2P	Peer-to-peer
PAC	Plateforme d'Archivage du Centre Informatique National de l'Enseignement Supérieur (Archiving Platform for National Computer Centre of Higher Education)
PAIMAS	Producer Archive Interface Methodology Abstract
PAIS	Producer Archive Interface Specification
PB	Petabyte = 1000 Terabytes
PILAE	Plate-forme Pilote d'Archivage Electronique (Pilot Platform of Electronic Archival)
R&D	Research and Development
RGB	Red Green Blue colour model
RLG	Research Libraries Group
SAA	Society of Audiovisual Authors
SD	Standard Definition
SERAD	Service for Data Referencing and Archiving
SMPTE	Society of Motion Picture and Television Engineers
SPAR	Système de Préservation et d'Archivage Réparti (Distributed Archiving and Preservation System)
SW/HW	Software/Hardware
TB	Terabyte = 1000 Gigabyte
TC	Technical Committee
TC21	Technical Committee 21 – the committee responsible for D-Cinema standards at SMPTE
TRAC	Trustworthy Repositories Audit & Certification
TV	Television
UK	United Kingdom
US	United States
VHS	Video Home System
VoD	Video on Demand
VTR	Videotape Recorder
XFDU	XML Formatted Data Unit
YoY	Year-on-Year

7.2 Appendix 2 – Funding instruments for film heritage

Funding for film heritage is possible under the following EU instruments:

1. **General overview**:
- „EU actions for bringing Europe's cultural heritage online", presentation by Richard Swetenham
  http://ec.europa.eu/avpolicy/docs/reg/cinema/sept_11/swetenham.pdf

- Eu Cohesion Policy and funding opportunities for film heritage summarised in the presentation by Pierre Godin:
  http://ec.europa.eu/avpolicy/docs/reg/cinema/june09/regional.pdf

- MEETING OF CINEMA EXPERT GROUP by Federico Milani:
  http://ec.europa.eu/avpolicy/docs/reg/cinema/oct10/support.pdf

2. **FP7 - Seventh Framework Programme for Research and Technological Development.**
   This is the EU's main instrument for funding research in Europe and it will run from 2007-2013
   http://ec.europa.eu/research/fp7/index_en.cfm

3. **Structural funds –**
   Information on the regulation of EU Structural Funds:
   http://ec.europa.eu/regional_policy/sources/docoffic/official/regulation/newregl0713_en.htm

4. **Competitiveness and Innovation Framework Programme 2007-2013**
   Especially the „ICT Policy Support Programme":
   http://www.2007-2013.eu/by_scope_ict.php

5. **Connecting Europe Facility 2014-2020**
   Infrastructure Connecting Europe Facility: energy, transport and digital networks:
   http://europa.eu/rapid/pressReleasesAction.do?reference=SPEECH/11/689&language=en

6. **MEDIA**
   Video on Demand and Digital Cinema Distribution:
   http://ec.europa.eu/culture/media/programme/newtech/vod_dcc/index_en.htm

7. **EIB - I2I - INNOVATION 2010 INITIATIVE**
   Strategy for implementation of the knowledge economy of the EIB, Europe 2020 and the Union for innovation:
   http://www.welcomeurope.com/european-funds/eib-i2i-innovation -2010-initiative-274+174.html

   Introduction presentation "Audiovisual Archives - Financing aspects" by Dr. Patrick Vanhoudt:
   http://ec.europa.eu/information_society/activities/digital_libraries/doc/mseg/meetings/7th/p_vanhoudt.pdf

Funding Opportunities:
Further information will be published on:

ICT-PSP
- http://ec.europa.eu/ict_psp
- http://ec.europa.eu/econtentplus

FP7 R&D
- http://cordis.europa.eu/fp7/ict/telearn-digicult/digicult_en.html

EDUCATION AND PROFESSIONAL TRAINING

Conclusions of the Spanish Conference - Filmoteca Espanola - Marc Vernet
http://ec.europa.eu/avpolicy/docs/reg/cinema/oct10/filmoteca.pdf

Examples of projects which have been financed:

FILM HERITAGE:
www.europeanfilmgateway.eu - CIP
EFG1914 - CIP
www.europafilmtreasures.eu - MEDIA
www.nitrofilm.pl - structural funds

AUDIOVISUAL ARCHIVES:
www.videoactive.eu – CIP
www.euscreen.eu - CIP
www.prestoprime.eu – Research

Useful information at the Cinema Expert Group:
http://ec.europa.eu/avpolicy/reg/cinema/experts/index_en.htm

7.3 Appendix 3 — The contributors to the study

Surname	Name	Organisation
BAUJARD	Thierry	Peacefulfish
BRUUN	Niklas	IPR University Centre
FEUER	Frauke	Peacefulfish
HACKETT	Andrew	Red Cat Technologies
HOURCADE	Jean-Char	Red Cat Technologies
MANSALA	Marja-Lee	IPR University Centre
MATA	Ruth	Peacefulfish
MAZZANTI	Nicola	Independent consultant
SCHULZE	Juliane	Peacefulfish

7.3 Appendix 3 — The contributors to the study

7.4 Appendix 4 – List of institutions/organisations contacted in the course of the Study

	Organisation	Country	Category
1	Academy of Motion Pictures Arts and Sciences - Archive	USA	Archive
	Academy of Motion Pictures Arts and Sciences - Tech Council	USA	Research
2	Allianz Deutscher Produzenten - Film & Fernsehen e.V.	DE	Industry
3	AMIA-Association Moving Image Archivists	USA	Association
4	ANICA (Associazione Nazionale Industrie Cinematografiche Audiovisive e Multimediali)	IT	Industry
5	Arhiva Nationala de Filme	RO	Archive
6	ARRI Film & TV	DE	Industry
7	Ascent Media UK	UK	Industry
8	Ascent Media USA	USA	Industry
9	Austrian Film Archive	AT	Archive
10	Austrian Filmmuseum	AT	Archive
11	Bavaria	DE	Industry
12	BBC	UK	Audiovisual Archive
13	Beeld en Geluid	NL	Audiovisual Archive
14	Belgacom	BE	Industry
15	Belspo - Belgian Ministry for Science	BE	Government
16	Bibliothèque Nationale de France	FR	Archive
17	British Film Institute	UK	Archive
18	Bulgarian National Film Archive	BG	Archive
19	Bundesarchiv - Filmarchiv	DE	Archive
20	Bundesministerium für Unterricht, Kunst und Kultur	AT	Government
21	Bundesverband kommunale Filmarbeit	DE	Industry
22	CEGES	FR	Industry
23	CENELEC	BE	Industry
24	Centre National de la Cinématographie	FR	Archive
25	Centre National de l'Audiovisuel	LU	Archive
26	Centrul National al Cinematografiei	RO	Archive
27	CEPI - European Coordination of Independent Producers	International	Industry
28	Cinemateca Portuguesa	PT	Archive
29	Cinematek	BE	Archive
30	Cinemateque de Toulouse	FR	Archive
31	Cinémathèque de Grenoble	FR	Archive
32	Cinematheque Française	FR	Archive

	Organisation	Country	Category
33	Cinematheque Montenegro	ME	Archive
34	Cinematheque of the Wallonie-Bruxelles Federation	BE	Archive
35	Cinémathèque Royale de Belgique	BE	Archive
36	Cinematheque Suisse	CH	Archive
37	Cineteca del Comune di Bologna	IT	Archive
38	Cineteca del Friuli	IT	Archive
39	Cineteca Nazionale	IT	Archive
40	Cinetheque municipale de Luxemburg	LU	Archive
41	CineXPRES project	BE	Industry
42	CNES	FR	Research
43	Consorzio Roma Ricerche	IT	Research
44	Constantin Film	DE	Industry
45	Croatian Audiovisual Center	HR	Archive
46	Croatian National Archive	HR	Archive
47	Croatian State Archive Croatian Cinematheque	HR	Archive
48	CRSiiMotion	DE	Industry
49	Cyprus Cinema Archive	CY	Archive
50	Cyprus Ministry of Education and Culture	CY	Government
51	Cyprus Ministry of Interior	CY	Government
52	Danish Cinemateque	DK	Archive
53	Danish Film Institute	DK	Archive
54	Deluxe Laboratories	USA / UK	Industry
55	Deluxe Laboratories Europe	UK	Industry
56	Department of Culture, Youth, Sport and Media – Flemish Government	BE	Government
57	Deutsches Film Institut	DE	Archive
58	Deutsches Filmmuseum	DE	Archive
59	Deutsches Kinemathek	DE	Archive
60	Digital Film Technology	DE	Industry
61	Digtal Film Lab	DK	Industry
62	DOREMI	FR	Industry
63	DVS	DE	Industry
64	East Anglia Film Archive	UK	Archive
65	Éclair	FR	Industry
66	EFG1914	DE	EU project
67	EGEDA	ES	Industry
68	EMPA - European Motion Picture Producers' Association	International	Industry
69	Estonian Film Archive	EE	Archive
70	EUROCINEMA	International	Industry
71	Eurokent Consultancy	BE	Research
72	European Audiovisual Observatory	BE	Research

	Organisation	Country	Category
73	European Commission's audiovisual Library	BE	Archive
74	European Digital Cinema Forum	UK	Industry
75	European Film Academy	Europe	Industry
76	European Film Gateway	DE	EU project
77	Europeana	International	EU project
78	EYE Film Institute	NL	Archive
79	Federal Ministry for Education, the Arts and Culture, Bi- and multilateral cultural affairs	AT	Government
80	FERA - Federation of European Film Directors	International	Industry
81	FERA (Fédération Européenne des Réalisateurs de l'Audiovisuel)	International	Industry
82	FFA - Filmförderungsanstalt	DE	Industry
83	FIAD Fédération internationale des associations de distributeurs de films	International	Industry
84	FIAF International Federation of Film Archives	International	Industry
85	FIAPF Féderation Internationale des Associations de Producteurs de Films	International	Industry
86	Filmmuseum Landeshauptstadt Duesseldorf	DE	Archive
87	Filmmuseum München	DE	Archive
88	Filmoteca de Catalunya	ES	Archive
89	Filmoteca Española	ES	Archive
90	Filmoteca Valenciana	ES	Archive
91	Filmoteca Vaticana	VA	Archive
92	Filmoteka Narodowa	PL	Archive
93	Finnish Broadcasting Company	FI	Industry
94	Finnish Film Foundation	FI	Industry
95	Fondazione Centro Sperimentale di Cinematografia - CN	IT	Archive
96	Fondazione Cineteca Italiana di Milano	IT	Archive
97	Fraunhofer Institute, Motion Picture Technologies Department	DE	Research
98	French Royal Academy of language and literature	FR	Research
99	FSE - Federation of Screenwriters in Europe	International	Industry
100	FUSART L'Art de l'Entreprise	BE	Industry
101	George Eastman House	USA	Archive
102	Global Warner Europe	BE	Industry
103	Gorizia University	IT	Archive
104	Gosfilmofond	RU	Archive
105	Greek Film Archive-Museum of Cinematography	GR	Archive
106	Greek Film Centre	GR	Archive
107	Hungarian Film Archive	HU	Archive
108	ICAA	ES	Government

	Organisation	Country	Category
109	IMAGO (European Federation of Cinematographers)	International	Research
110	Imperial War Museum	UK	Archive
111	INA Institut National de l'Audiovisuel	FR	Audiovisual Archive
112	Institut für Medienforschung, Hochschule für Bildende Künste	DE	Research
113	Institut Lumière	FR	Archive
114	Institut National du Patrimoine	FR	Research
115	Institut Valencià de L'audiovisual	ES	Archive
116	Instituut voor Beeldende, Audiovisuele en Mediakunst (Flemish Institute for Visual, Audiovisual and Media art)	NL	Government
117	Irish Film Archive	IE	Archive
118	Irish Film Board	IE	Government
119	ISAN International Agency	International	Industry
120	IVF International Video Federation	International	Industry
121	Jugoslovenska Kinoteka	SB	Archive
122	KAVA, National Audiovisual Archive	FI	Archive
123	KEA European Affairs	BE	Research
124	Kinemathek Bern	CH	Archive
125	L'Immagine Ritrovata	IT	Industry
126	Lithuania Archives Dept	LT	Government
127	Lithuanian Central State Archive	LT	Archive
128	MEDIA Desk Belgium	BE	Government
129	Ministère de la Communauté française, Service général de l'audiovisuel et des multimédias	BE	Government
130	Ministerstwo Kultury i Dziedzictwa Narodowego	PL	Government
131	Ministry of Culture	NO	Government
132	Ministry of Culture	BG	Government
133	Ministry of Culture	CZ	Government
134	Ministry of Culture and National Heritage	PL	Government
135	Ministry of Culture and National Heritage	PL	Government
136	Ministry of Culture of the Republic of Lithania	LT	Government
137	Ministry of Justice and Law	HU	Government
138	MPA - Motion Picture Association	USA	Industry
139	Museo Nazionale del Cinema	IT	Archive
140	NARODNI FILMOVY ARCHIV	CZ	Archive
141	National Audiovisual Archive (NAVA)	HU	Archive
142	National Audiovisual Archive Finland	FI	Archive
143	National Audiovisual Institute Poland	PL	Government
144	National Film Center of Latvia	LV	Archive
145	National Film Institute	NO	Archive

	Organisation	Country	Category
146	National Library of Norway	NO	Archive
147	National Screen and Sound Archive of Wales	UK	Archive
148	National Screen and Sound Archive of Wales	UK	Archive
149	OEA Eurimages	International	Research
150	Österreichisches Filmmuseum	AT	Archive
151	PepperPost	UK	Industry
152	Polish National Audiovisual Institute	PL	Archive
153	Reelport	DE	Industry
154	Representation of the Free State of Bavaria to the EU	DE	Government
155	Royal Belgium Film Archive	BE	Archive
156	RTBF	BE	Audiovisual Archive
157	SAA (Society of Audiovisual Authors)	International	Industry
158	Screen Digest	UK	Research
159	Silesian University in Opava / Charles University in Prague	CZ	Research
160	SIST - Service d'information scientifique et technique	BE	Research
161	Slovak Film Institute, Film archive	SK	Archive
162	Slovak Film Institute. The Documentation and Library Services Department	SI	Archive
163	Slovenska Kinoteka	SI	Archive
164	Slovenski Filmski Arhiv	SI	Archive
165	SONUMA	BE	Audiovisual Archive
166	Sony Columbia	USA	Industry
167	Stiftung Deutsche Kinemathek	DE	Archive
168	StudioCanal	FR	Industry
169	Svenska Filminstitutet	SE	Archive
170	Tainiothiki Tis Ellados	GR	Archive
171	The Haghefilm Foundation	NL	Industry
172	The Polish Film Insitute	PL	Government
173	Twentieth Century Fox	USA	Industry
174	UCLA Film & TV Archive	USA	Archive
175	UNIC (Union Internationale des Cinémas)	International	Industry
176	Université Paris VII	FR	Research
177	University of London	UK	Research
178	University of Wien	AT	Research
179	Warner Brothers	USA	Industry
180	XDC	BE	Industry

7.5 Appendix 4 – List of registrations to the workshop

	NAME	SURNAME / FAMILY NAME	ORGANISATION	JOB TITLE
1	Christos	AIVALIOTIS	EUROCINEMA	Assistant
2	Giulia	BARINI	Goriza University	Archivist and Movies restorer Degree
3	Stéphane	BAYOT	SONUMA	Operational Responsible
4	Jan-Erik	BILLINGER	Swedish Film Institute	Head of Film Heritage Department
5	Jurgen	BOEL	Department of Culture, Youth, Sport and Media – Flemish Government	Policy Officer
6	Leontien	BOUT	EYE Film Institute	Coordinator Legal & Access
7	Cristina	BUSCH	IMAGO (European Federation of Cinematographers)	Lawyer
8	Anna	CALDERONE	Belgian Science Policy	Programme Manager
9	Andy	CARLING	New Europe	Journalist
10	Thomas C.	CHRISTENSEN	Danish Film Institute	Curator
11	Elena	CHRISTODOULIDOU	Cyprus Ministry of Education and Culture	Senior Cultural Officer
12	Andreas	CHRISTODOULOU	Cyprus Ministry of Interior	Head Media Section
13	Mariette	COLINET		Retired Official EC
14	Paul	COLLARD	Ascent Media Group	Vice President Film & Digital Services
15	Yvan	CORBISIER	Belgian Cinema	Audiovisual Journalist
16	Jarosław	CZUBA	National Audiovisual Institute Poland	Deputy Director
17	Jacques	DE DECKER	French Royal Academy of language and literature	Secretary
18	Victor	DE VOCHT	Royal Belgium Film Archive	Maintenance of Collection

	NAME	SURNAME / FAMILY NAME	ORGANISATION	JOB TITLE
19	Pierre-Yves	DEFOSSE	Belgacom	Executive Account
20	Wim	DEVOS	Federal Government – Scientific Policy Ministry	
21	Milena	DIMITROVA	Permanent Representation of the Republic of Bulgaria to the EU	Counsellor for Culture and Audiovisual Policy
22	Olivier	DOCK	MPAA (Motion Picture Association)	Vice President, All Media - Europe, Middle East & Africa
23	James	DREW	New Europe	Journalist
24	Gilles	DUFFAU	Cinematheque Française	Head of New Media Initiatives
25	Gilbert	DUTERTRE	INA (Institut national de l'audiovisuel)	Head of Audiovisual Cultural Heritage Fund
26	Georg	ECKES	Deutsches Filminstitut (DIF)	Project Manager
27	Charles	FAIRALL	British Film Institute	Head of Conservation
28	Jean-Christophe	FINIDORI	FUSART L'Art de l'Entreprise	President
29	Gillet	FLORENCE	CEGES	Image and Sound responsible
30	Siegfried	FOESSEL	Fraunhofer IIS	Head of Department Moving Picture Technologies
31	Alessandra	FRATINI	ANICA (Associazione Nazionale Industrie Cinematografiche Audiovisive e Multimediali)	Representative
32	Roman	GADNER	ARRI	Product Manager ARRILASER
33	María	GARCÍA BARQUERO	Filmoteca Española	Head of Cooperation
34	Michael	GILLESSEN	XDC	Content & Network Services – Operations Manager
35	Alain	GOOSSENS	Cinematheque of the Wallonie-Bruxelles Federation	Director
36	Thilo	GOTTSCHLING	ARRI Film & TV	Head of Restoration and Archive
37	Lise	GUSTAVSON	Norwegian Film Institute	Head of Audience Section
38	Andrew	HACKETT	Red Cat Technologies	Member of the Study Consortium

	NAME	SURNAME / FAMILY NAME	ORGANISATION	JOB TITLE
39	François	HELT	Doremi	Technical Director measurement and preservation
40	Jelmer	HOFKAMP	CEPI (European Coordination of Independent TV Producers)	Policy Advisor
41	Sebastian	HORLEMANN	Permanent Representation of Bavaria	Intern
42	Jean-Charles	HOURCADE	Red Cat Technologies	Member of the Study Consortium
43	Vincent	JAMOIS	Global Warner Europe	Time Warner Europe
44	Lars	KARLSSON	Swedish Film Institute	Acting Head of IT
45	Ruth	KELLY	British Film Institute	Head of Collections and Information
46	David	KLEINGERS	Deutsches Filminstitut (DIF)	
47	Tadeusz	KOWALSKI	Filmoteka Narodowa (Polish National Film Archive)	Director
48	Paulina	KUFEL	Permanent Representation of the Republic of Poland to the EU – Education, Youth, Culture and Sport Section	First Secretary
49	Annick	KUHL	Representation of the Free State of Bavaria to the EU	Representative
50	Mikko	KUUTTI	National Audiovisual Archive Finland	Deputy Director - Member of the Study Advisory Board
51	Juan Ignacio	LAHOZ RODRIGO	Filmoteca Valenciana	Curator
52	Elena	LAI	CEPI (European Coordination of Independent TV Producers)	Secretary General
53	Thierry	LECLERCQ	MEDIA Desk Belgium	Representative
54	Ronny	LOEWY	Deutsches Filminstituut (DIF)	Cinematographic Works: Standars
55	Charlotte	LUND THOMSEN	IVF (International Video Federation)	Director General
56	Magda	MAHER	Council of the EU	Official
57	Marja-Leena	MANSALA	IPR University Center	Member of the Study Consortium
58	Erik	MARTENS	Cinematek	Head, DVD publications

	NAME	SURNAME / FAMILY NAME	ORGANISATION	JOB TITLE
59	Ruth	MATA	peacefulfish	Member of the Study Consortium
60	Nicola	MAZZANTI	Royal Belgium Film Archive	Member of the Study Consortium
61	Heidi	MEISSNITZER	Permanent Representation of Austria to the EU	Head of Unit Federal Ministry for Education, Arts and Culture
62	Bruno	MESTDAGH	Cinematek	Collection and Digitalisation Dpt.
63	Anna	MISIEWICZ	National Audiovisual Institute Poland	Lawyer
64	Dries	MOREELS	Instituut voor Beeldende, Audiovisuele en Mediakunst (Flemish Institute for Visual, Audiovisual and Media art)	Project Manager
65	Miloslav	NOVAK	Silesian University in Opava / Charles University in Prague	Researcher
66	Elisabeth	O. SJAASTAD	FERA (Fédération Européenne des Réalisateurs de l'Audiovisuel)	Chief Executive
67	Jon Arild	OLSEN	National Library of Norway	Head of Film and Music Sector
68	Vladimir	OPELA	National Film Archive of the Czech Republic (NFA)	Director of National Film Archive
69	Rebekka	OPFERMAN	peacefulfish	Member of the Study Consortium
70	Burak	ÖZGEN	Eurokent Consultancy	Partner-Consultant
71	Gaia	PANDOLFI	ANICA (Associazione Nazionale Industrie Cinematografiche Audiovisive e Multimediali)	Representative
72	Elena	PHALET	SIST - Service d'information scientifique et technique	Scientific Collaborator
73	Arnaud	QUTTELIER	RTBF	Journalist
74	Paul	READ		Keynote speaker
75	Emjay	RECHSTEINER	EYE Film Institute	Curator
76	Jan	RUNGE	UNIC (Union Internationale des Cinémas)	Chief Executive
77	Silvia	SALANSKA	Permanent Representation of the Slovak Republik	Representative Culture, Audivisual and Copyright

	NAME	SURNAME / FAMILY NAME	ORGANISATION	JOB TITLE
78	Tilman	SCHEEL	Reelport	Managing Director
79	Juliane	SCHULZE	peacefulfish	Member of the Study Consortium
80	Marcello	SEREGNI	Italian film heritage institutions	Curator and Archivist
81	Walter	SWAGEMAKERS	EYE Film Institute	Collection Manager
82	James	TAYLOR	SAA (Society of Audiovisual Authors)	Public Affairs and Communications Officer
83	Yvon	THIEC	EUROCINEMA	Managing Director
84	Ivi	TOMINGAS	Estonian Film Archive	Director
85	Luc	VAN DEN BERGHE	CENELEC	Programme Manager - Innovation
86	Erwin	VERBRUGGEN	CineXPRES project	Project Worker R&D
87	Marc	VERNET	INP	Advisor
88	Anna	VONDRACEK	KEA	Researcher
89	Alexandre	WEISER	XDC	Digital Media Services – Sales Director
90	Jon	WENGSTRÖM	Swedish Film Institute	Curator of Archival Film Collections
91	Martina	WERTH-MÜHL	Bundesarchiv-Filmarchiv	Deputy Director
92	Markus	WESSOLOWSKI	Österreichisches Filmmuseum	Film Collection