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Audiovisual Media Preservation**

## **D4.1: Business, Economic and Licensing Routes for Technology Take-Up**

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## Scope

The long-term preservation of digital audiovisual media presents a range of complex technological, organisational, economic and rights-related issues, which have been the subject of intensive research over the past fifteen years at national, European and international levels. Although good solutions are emerging, and there is a large body of expertise at a few specialist centres, it is very difficult for the great majority of media owners to gain access to advanced audiovisual preservation technologies. Presto4U will focus research efforts onto useful technological solutions, raise awareness and improve the adoption of audiovisual preservation research results, both by service providers and media owners, and with a particular emphasis on meeting the needs of smaller collections, private sector media owners and new stakeholders.

The Presto4U project's Workpackage 4 aims to encourage the adoption of technologies emerging from digital preservation R&D that solve problems experienced by the Communities of Practice (CoPs) but which have not yet reached the market. More specifically, Task 4.1 will identify and review the barriers preventing the adoption of research results and analyse various possible routes to uptake. We will analyse the economics and business models for product or service based approaches. The work will include the analysis of IP licensing models and the development of commercial validation paths. We will develop models for brokerage that show the process of matching representative CoP requirements to technology service providers, which will inform the future conduct of trials through to the provision of technology solutions on suitable licensing terms.

This project deliverable, D4.1, presents an analysis of different routes to take-up of research outputs by end-user communities and their supply side. It is intended to serve as a practical guide to inform and advise these users on suggested best practices, etc.

# 1 Introduction

This Presto4U report is focused on the identification and analysis of barriers preventing the adoption of research results as well as novel technologies, tools and standards. It provides an analysis of the main issues on outcome adoption by Communities of Practice (CoPs), as clustered in the context of the Presto4U project, proposing possible routes to uptake.

Economics and business models for product or service based approaches are discussed, including the analysis of IP licensing models and the development of commercial validation paths.

This report is intended to serve as a practical guide to inform and advise Communities of Practice in digital AV preservation on potential issues and critical aspects that hinder the introduction within their environments of research outcomes and innovative technologies.

The document is clearly structured in three parts: Chapter 2 investigates the mechanisms for licensing research outcomes that meet the preservation needs of audiovisual archives, and the motivations of the three main stakeholder groups. In this chapter we look at different licensing types and structures suitable for licensing research outcomes, and propose a milestone based approach for validating the suitability of research outcomes for licensing in either commercial products or custom solutions for a single or small group of users. Chapter 3 analyses the barriers that are preventing the adoption of research results, considering the various stakeholders we have within Presto4U, and highlights the potential barriers that are blocking the diffusion and adoption of the novel arising technologies, tools and standards. Finally, Chapter 4 provides general conclusions and guidance in order to promote the adoption of technologies and to avoid barriers that can prevent their implementation within Communities of Practice.

We intend to produce and publish the chapters of this report into separate publications for wide dissemination within relevant target groups, to create attention for the topics addressed and to realise a strong impact amongst stakeholders. The impact of our work may not become immediately apparent during the timescale of the Presto4U project, but we trust that the PrestoCentre as well as other support organisations in the area of digital AV preservation will take this report to identify positive changes and propose further updates and improvements for the future.

## 2 Intellectual Property and Routes to Market

This chapter explores the mechanisms for licensing research outcomes that meet the preservation needs of audiovisual archives; we explore these mechanisms from the perspective of each of the main stakeholder groups, The Archivist, The Researcher and The Vendor (a company that supplies a product to meet the preservation need).

At a high level we look at the influencing factors that will drive a decision on how to acquire a new technology, looking specifically at the research to delivery chain from applied research projects to open source adoption to buying a product 'off the shelf'. The aim is to provide the reader with a useful perspective that will aid in the decision making process when considering how IP is developed and licensed, the various approaches that can be taken to acquiring a solution to preservation needs and how to approach such things as commercial license negotiation.

At the centre of the Audiovisual Archiving world exists a conundrum: the scale of the technical challenges faced by audiovisual archives is large and permanent but the number of players is relatively small and their budgets cyclical. These are not the attributes of an addressable marketplace that is commercially attractive to many companies and therefore requires that the approaches taken to solving the challenges faced by archives must spread wider to collaborative research, adaptation of useful open source technology and even exploring entirely new 'digital' business models in a drive to offset current costs against future value.

### 2.1 The Landscape

In recent years, as the professional and consumer AV industry has moved through the digital divide into tapeless workflow and management of digital assets, many technology vendors operating in the Post Production and Broadcast sectors have developed tools that are marketed as 'Archive' solutions. However these products tend to target the needs of television production archives rather than the specific preservation needs of the wider Audiovisual Archive community, which spans a range of sectors outside of Broadcast (as represented in the several Communities of Practice formed by the Presto4U project). The digitisation of physical media collections and the development of technology to facilitate ingest, migration, storage and fixity has supported the development and growth of a number of specialised technology vendors in the space in the past decade. Great progress has been made and healthy levels of industrial / institutional collaboration, supported by framework funding from the European Commission, have provided solutions to problems faced by Audiovisual Archives across a range of sectors. An example of one such success is included as a case study appendix to this report, which explores the transfer of research undertaken during the 1990's under the EUREKA and ESPRIT programmes, and later the EC IST Project DIAMANT in 2000 into film restoration

technology. The results are now at the core of a Film Restoration system brought to market by a startup company formed for that specific task. The company HS-ART Digital Service GmbH has continued to market these research outcomes through its widely adopted DIAMANT-Film Restoration product line for more than a decade. The timeline of research to adoption in this case study highlights the length of time required to undertake research and foster adoption of research outcomes in this sector, and the need for sustained investment over many years.

Within the solution development ecosystem we have three main stakeholder groups:

1. Researchers
2. Industry vendors
3. Archive practitioners

Researchers can develop useful IP alone, or in collaboration with industry vendors who will build products that can potentially license that IP. Archive practitioners can choose to develop or acquire IP or products through a number of routes. Each stakeholder group has a different set of motivations for involvement in the development of solutions.

One challenge faced by smaller archives or organisations (for whom audiovisual archiving may be a smaller component of their available efforts) is in finding and deciding how to implement solutions to the problems they face. Whilst commercial solutions may be available, they may not suit the scale or shape of needs within the organisation or their budget and therefore an organisation must explore the viability of alternative approaches.

One such approach could be through the implementation of Open Source technology or, where no suitable commercial or open source solution exists, to engage in applied research activities to deliver a solution.

For an Archive considering what approach to take in acquiring a solution to a need there are a number of factors that will influence each path. Broadly speaking we can segment the landscape into three separate focus areas:

- Applied Research
- Open Source
- Commercial Solution

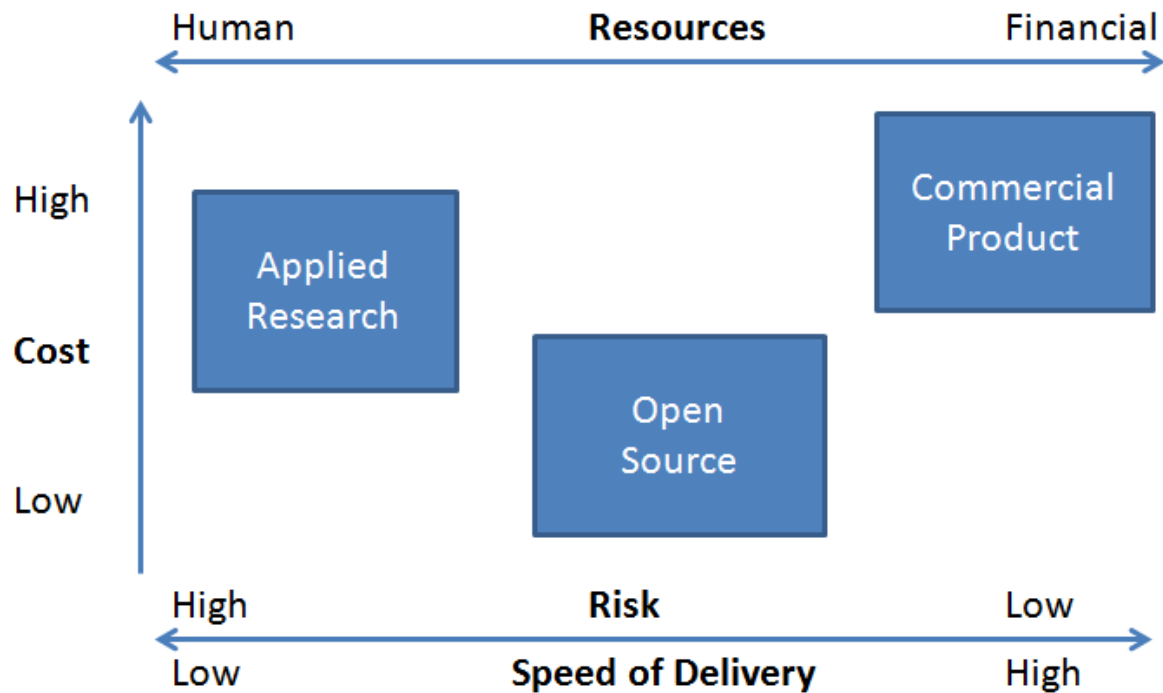


Figure 2.1: Types of solution

Applied Research is an approach to solution development where no suitable solution currently exists or a significant barrier exists to accessing an existing solution (e.g. it is a component of a wider system that is too expensive). Applied research can be a useful way to develop solutions to very specialised needs but requires significant financial resources and access to researchers with the requisite skills and specialisation.

Applied Research may accrue additional benefits to the organisations engaging in the delivery of a successful research outcome as this may provide an opportunity to license the technology beyond the four walls of the organisation conducting the research. However this approach also presents great risk as the outcomes are unknown and success is not guaranteed. Research projects by their nature take time and therefore participants must take a long term view and be prepared to reinvest should results be in sight but further out than expected.

One key consideration for both Archives and Commercial companies engaging in applied research projects is to check expectations with regard to the operational suitability of the research outcome. It will often fall on the organisation applying the research outcome or the company developing a product to bring the research outcome to an application ready state.

Open Source technology is often seen as a low cost means of solution acquisition, however, similar to applied research projects, any institution seeking to implement an



open source solution must have the human resources or access to services to support the application of the solution. While open source technology is often well supported by the community who use it, this is not guaranteed, therefore an organisation adopting such technology is well served by having resources available to integrate, modify and support internally. Organisations that adopt open source technology without having the internal resources to integrate and support may overcome this challenge by outsourcing these tasks; both approaches require both human and financial resources.

A commercial solution can refer to licensing code or specific IP on commercial terms; this is explored in more detail later in this section. In this instance, we refer to the purchase of a shrink-wrapped product such as a piece of software with a defined license and cost. The main benefit in acquiring a suitable solution in the form of a commercially available product is speed of delivery and scalability. A commercially available solution may often be turnkey, subject to a future development roadmap, provide integration with other solutions and the support provided by a commercial vendor can also offset the operational cost of supporting a solution in-house.

## ***2.2 Routes to Market***

The Market for solutions in the audiovisual archiving sector is a simple two-sided marketplace with Practitioners on the demand side and Researchers and Vendors on the supply side although there are examples where these lines can blur, which are discussed later in this section.

For the supply side of this marketplace, a range of options exist for each of the two groups. Researchers and Vendors can choose to collaborate or to provide solutions direct to the demand side.

Options for the Researcher include:

- Release Open Source (e.g. on SourceForge)
- Release as “dual license”, non-exclusive
- Exclusive license to selected commercialisation partner
- Knowledge transfer agreement with selected partner
- Commercialise through spin out company

Options for the Vendor include:

- Take and develop available open source code
- Licence code from developer
- Enter into knowledge transfer agreement with researcher
- Develop technology in house

For example, a research group creates a potentially saleable piece of IP and is looking to exploit it, or at least make it available for use commercially. What are their options, and what does each imply?

**A.** Sell the IP outright to a third party. Irrespective of the nature of the third party (who could be a large commercial company, an SME, a third party broker or a newly formed company) the result is to hand over code, documentation and rights to usage. The benefit of this tactic is that a lump sum is received up front without any guarantee of performance of the software or its revenue generating capability (technical and commercial audit and valuation of the IP is the responsibility of the purchaser), and there are no further costs relating to support and maintenance of the software, responsibility for which is taken on by the purchasing organisation. The disadvantages are that the research group creating the IP loses all control, potentially losing the ability to further develop or build on the IP; they lose the opportunity to create future revenue out of the IP and could find that they have under-sold in terms of the return that the purchaser actually makes from its exploitation.

**B.** License the IP to a third party. Licensing has the benefit that the research organisation retains control of their IP and can further develop it or license to others (if they avoid exclusive licensing). The license conditions can reflect the commercial success of the IP by linking to sales volume, revenue/profit generated or market value of the licensee. The disadvantages are that support and maintenance of the software remains with the research organisation, and there is an ongoing cost of revenue tracking and collection and maintenance of the commercial competitiveness of their product.

**C.** Retain IP and exploit it internally. The research organisation may choose to exploit their IP through a spin-out or directly from an internal group. Exploitation through a spin-out is very similar to the previous sell or license discussions, with the added potential disadvantage that control of the IP can be lost if the spin-out is re-capitalised or liquidated through sale to a third party investor or large company. Costs of marketing and support will fall to the IP holder if they choose to exploit for themselves, which can be a drain on resources and is often incompatible with the normal operations of a research group.

When considering the exploitation of research results, there are three principal stakeholders, each of whom has a unique viewpoint on what they want to get out of research tools, and their motivation for using them. These three stakeholders are the researchers (who create the research output and hold the initial IPR), the

commercialising entity (that takes and offers the IPR to customers) and the user (who is ultimately interested in using the research output to do a certain job).

Each of these stakeholders has their own set of motivations for what they do (which might not be compatible with each other of course), but for the whole chain to work they all have to satisfy their needs one way or another.

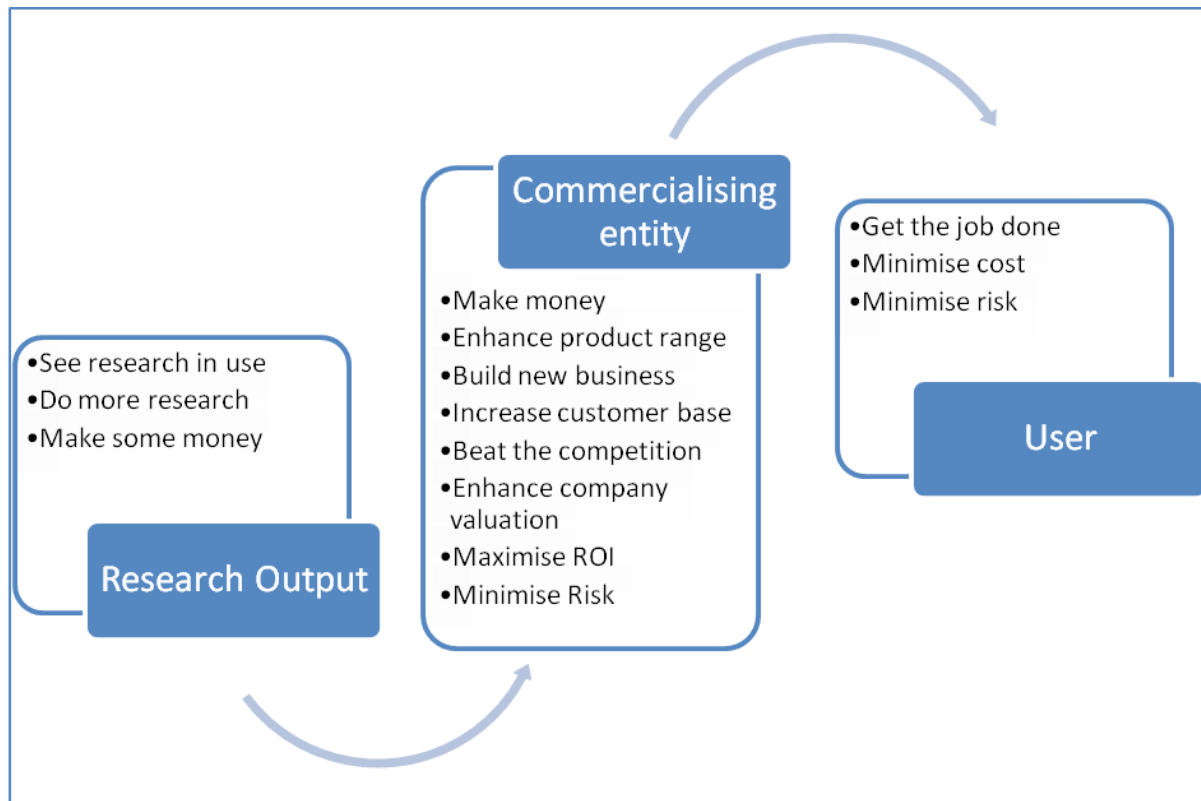


Figure 2.2 Motivation of Stakeholders

### 2.3 The Researcher

The researcher is more often than not driven by a desire to see their work being used in some way or other. Whether that is seeing something on the shelves in the local shops or seeing a product being used beneficially by someone, the result is the same and brings a sense of satisfaction. The researcher also wants to be able to do more research. This may sound obvious, but researchers don't like to be prevented from doing their work by IPR limitations, and they see themselves as free thinkers who come up with great ideas. Of course, money is still a motivation, and a researcher will often believe that their ideas have a high commercial value. This isn't always true, and it may be that a great idea doesn't offer a commercial organisation the opportunity to make the all-important profit, but this is not always obvious to the researcher owning the IP.

In order to achieve these objectives, the researcher has a number of routes to market that they can take, each with advantages and disadvantages which must be carefully weighed up. On the assumption that the researcher has created a piece of identifiable intellectual property (IP) in the form perhaps of software, algorithm, design or simply unique knowledge, the first decision is whether to make the IP publically accessible or to retain ownership and aim to gain financial benefit from its exploitation. Software can be made available open source, or knowledge can be published in a publically accessible forum. This has the advantage that there is no obligation on the researcher to maintain or develop the research any further – anyone making use of their ideas might be expected to acknowledge its provenance, but would be free to make their own implementation and would take on the costs of development and support. The disadvantage to the researcher would be a loss of control over their ideas, and loss of any financial benefit that might accrue. A half-way house that is available is to release designs or software as “dual license”. This means that, for certain specified applications such as non-profit research, the IP can be used with an acknowledgement and without compromising original ownership. Any commercial exploitation of the IP would be licensed from the researcher. For their part, the researcher must ensure that the IP does not incorporate any “viral” open source elements (which corrupt the IP they are built into) or any commercial components, which may be used under an academic license during the research phase but which carry their own license conditions for any commercial user of the IP package.

If the researcher believes that there is the opportunity to generate financial benefit out of their IP then they have some different options available to them, which will involve a higher investment of time to realise. If a commercial partner can be identified, then a direct, exclusive license agreement may be possible. Ideally this would allow the researcher to retain the ability to further develop their research work, whilst permitting the commercial organisation to take the IP and make the investment themselves to develop and exploit a product on the basis of it. The license can take the form of a one-off payment or a royalty basis dependent on sales revenue achieved (or some combination of the two). The commercial company will be looking to minimise their risk and exposure, whilst the researcher will be looking to maximise their likely income. It is possible to sell IP in its entirety to a commercialising organisation, but this can have the disadvantage to the researcher of losing control over their research stream, and will very often result in them being unable to continue developments in this area, and should be avoided.

The other option that a researcher might consider would be to create a spin-out company through which they can take their research to market. Although this sounds an attractive option, and has been followed successfully by a number of researchers in a variety of disciplines, there are some fairly stringent requirements that need to be met for this to be a viable route to market. Firstly, the researcher needs to be very

confident that their IP is unique and has a genuine market. Simply having a gut feeling that there is a business is not enough – any investor will need solid proof that the IP is ready for market and that there is a significant customer base. The researcher will need to find a source of investment – research quality IP is not of the quality expected for commercial use, and generally needs ruggedisation and support before a user can feel confident enough to use it in their business. Any investor will be looking for a longer term business than a single piece of IP research offers – they will want to know how the business will evolve, what new and unique IP will be added and, crucially, what investment is going to be needed before the business is able to start generating revenue. If the customer base is too small and the investment to bring the IP to market is too high, then the per customer cost may be higher than they are prepared to pay or can justify, and in this case a spin-out company will simply not be viable. This is not to say that a spin-out route doesn't work – in many cases it has done – but that it is a long and difficult road and one that many researchers would prefer not to follow, if it means they are taken away from their primary role of creating IP and into a world of commerce and financial necessity.

## ***2.4 The Commercialising Entity***

The commercialising entity (which could be a large corporation or a start-up as is the case within the case study of HS-ART GmbH included as an Annex to this report) is driven by different motivations compared to the researcher, who creates the intellectual property in the first place. All businesses rely on innovative product offerings to stay in business – and staying in business requires that income generated from sales exceeds costs. In other words, businesses have to make money, and any prudent business will do a thorough cost-benefit analysis before committing to the commercialising of a new product idea. Having said this, it is also incumbent on businesses, particularly those in the technology sector, to innovate and to introduce new or improved product lines in order to retain their customer base and maintain a successful position against their competitors. So the dilemma faced by technology businesses is how to differentiate innovations with the potential to increase revenue from those that are going to lose the company money.

No company can guarantee that the market will evolve in the way they anticipate – if they could then there would be no business failures and the world would be a very different place. The best that a company can hope to do is to minimise their exposure to the risk of failure. Different sizes and financial bases of companies will approach this problem differently, so let's consider the challenge from a number of different angles.

### **2.4.1 The big corporation**

One of the principal characteristics of a large organisation is that the corporate management is driven by economic considerations, and is not often so interested in the technology underlying their products. This means that a researcher from their own R&D department, or a researcher from outside the organisation, needs to make a strong case for new technology development – a case that is built on the financial benefits, not on the cleverness of the technology. This is a difficult role for researchers to play, and to be successful they need to work with the commercial and marketing arms of the company to show an adequate customer take up to justify the investment in development. A big corporation will also have other considerations. Existing customers need to be supported, and existing product lines should be reinforced by any new developments rather than replaced. There is an investment involved in the development effort needed to bring new IP to the market, and for a large corporation that investment will come from company budgets – in other words the cost will come off the bottom line. This means that the management will be looking for a short pay-back period [6], probably within one or two financial years, a requirement that mitigates against investment in new markets or completely new product lines. It is for this reason that large corporations tend to be risk averse, and will more often buy smaller companies that have done the investment and market development already rather than make the investment in-house.

### **2.4.2 The SME**

Small and medium enterprises are characterised by having management teams who are close to the technology being developed, and are accessible to the researchers directly. They are far less risk-averse than their big corporate counterparts, but will generally be looking for external investment or capital in order to invest in a new venture. SMEs may have some of their own researchers, but will also be looking to collaborate with researchers in academia or research centres to identify IPR that could be turned into a product. They need to make a profit, otherwise they will go out of business, but they can be more flexible than a large corporation, and with a lower cost base they can afford to work within a more specialised market place. This is not to say that exploitation by an SME is a guaranteed route to market. Whilst they are certainly more prepared and interested to collaborate with IP owners, and are more amenable to supporting knowledge transfer initiatives with academic groups, there can be obstacles to an effective relationship. The typical SME is working in a tough business environment, where sales of existing products inevitably take precedence over new product development. Very often the relationship with researchers is seen as an interesting but non-core activity, and so fruitful engagement with SME management can suffer when immediate commercial demands take precedence. There is also the very real risk that an SME will change its nature mid-course. Either through re-capitalisation or sale to a larger organisation, control of the SME can change from a technical to an economic focus, in which existing product lines are

developed and research relationships are abandoned by a new and more financially driven management. Thus the very process of securing funding to invest in bringing IP to market can bring an SME to the point where they cannot go all the way to market, and a very well thought-through costed business plan is an essential part of preparing for a new product development.

### **2.4.3 The start-up**

Start-ups are generally built around a particular new product offering, often coming out of a research group, a private individual or sometimes as a break-away from a larger organisation unwilling to invest in commercialisation of research (see discussion above regarding large enterprises). Such start-ups are, by their nature, much less risk-averse than other initiatives. They do not have an existing market to maintain, and are generally trying to create a new market for an innovative product or are trying to take customers in an existing market place from established mainstream products into adopting their new product offering. From this point of view, a start-up would appear to be the ideal partner for taking on and exploiting a new research output, especially one where the customer need is well defined and the research is well developed. However, there are some considerations that should be borne in mind when following this route. If the start-up is the result of the IP holders setting up on their own, there will be considerable enthusiasm for developing the product, but this enthusiasm may not be matched by the size of the market or the revenue generation potential of the product. The entrepreneurs need to be very focused on the viability of their business rather than the technology, and they need to ensure that the customer base is willing to buy from a new commercial entity, and is prepared to pay enough for the product to cover business costs. Investment costs can be lower for a small start-up, and they should be prepared to work with their launch customers to ensure the developed product suits their needs, but the customer will also want to know that the business is going to be sustainable, and that ongoing support and development for the product will be available over the coming years. This can be influenced by the anticipated exit strategy of the start-up investors. With a strong enough business they can grow the business, taking on new products and extending the range.

The more likely route, however, is for the investors to look for a sale or (if the business is successful) IPO, which may mean that the product will end up as part of the product line of a large established business. Whilst this is not necessarily a bad thing – after all, no one ever got fired for buying from IBM – it can lead to situations where a useful and economically priced product becomes part of a larger, less affordable proprietary system.

### **2.4.4 Commercialising entities in summary**

A research output can be brought to market through a number of different routes, and a researcher is well advised to consider the advantages and disadvantages of

each. But at the end of the day, an effective commercialisation of research is only possible if the economics work out. No matter what size the commercialising entity, the research output they bring to market must return more in revenue than it costs in investment – and the break-even point needs to be reached before the investors lose patience. There is a significant investment involved in developing and supporting a piece of research IP such that it can be presented as a viable product. A market of customers must exist, who need to see a benefit from access to the product, and must also be prepared to pay for it. Effective collaboration between those who want to use the results of the research – the users – and the business looking to make the research available as a reliable and supported product is an essential part of the process of making research outputs useful and usable.

#### **2.4.5 The role of the Broker**

The brokerage function is one in which a third party (the broker) identifies the needs of the demand side of a market place and matches these with the capabilities of the supply side, bringing together both parties, to their mutual benefit and, in certain cases, with some commercial benefit to the broker.

Within the context of transfer of research outcomes to users in the Audiovisual Preservation marketplace, there is a strong role for a Broker as there are a wide range of actors to be understood and the connection of the supply side of the marketplace to the demand side (e.g. archive practitioners) has a higher chance of success if multiple users on the demand side can be identified.

In the present day marketplace for Audiovisual Preservation Solutions there are not yet any clearly defined brokers, however the Presto4U project is fulfilling this role through the development of brokerage tools that will match user requirements with potential solutions in the form of research outcomes and software tools; it will be up to the Communities of Practice who use the brokerage tools through the 'Presto4U Marketplace' to leverage the information that will be provided through these tools to best effect. It is the aim that an organisation or body fulfilling the role of broker will catalyse the impact of the brokerage tools through proactive use and continued promotion if that broker is motivated in some way. Presto4U does not seek to profit from this brokerage role and cannot provide or sustain the role of broker, as it has no legal basis to provide such services on an ongoing basis. The project will investigate whether and how the PrestoCentre can take up this role and proactively engage with both the supply and demand side of the audiovisual preservation marketplace, to foster collaborative projects that will see the transfer of research from projects and academic sources to users and commercial vendors. It is not clear at this point what specific business models might underpin such a role, and this will be further explored as part of Workpackage 6.



## 2.5 The User

The user is primarily motivated by a need to ‘get the job done’. In the Audiovisual Archiving space, the job is more often than not a large one, with limited solutions available, so the user must choose with care and perform due diligence upon any solution in light of all industry standards, support and format issues that may influence the outcome. In a scenario where options exist for a solution to be acquired through the purchase of a software product or the integration of an open source alternative, the decision will be driven by a balance between cost or available resources and risk.

At a deeper level, the User’s decision may be driven by their need to create or acquire a solution for internal use only, which may mean that certain compromises can be made with regard to the available feature set or the urgency of solution deployment. Where a user seeks to acquire a technology that will aid in the delivery of a commercial goal (where the return on investment metrics are more easily identified and measurable) this may motivate the organisation to acquire a solution more rapidly. For example an Archive who seeks to solve a preservation challenge relating to the preservation of a stable medium may not be under time pressure to deliver a solution within a short-term window of opportunity and can therefore explore a wider range of approaches. However, if the driver is to maximise impact during a short window of opportunity to undertake a preservation task or to exploit an outcome in a commercial way such as through the sale or licensing of digital content, the appetite for investment and velocity at which a project will run can increase significantly.

Audiovisual Archives can hold a wide variety of media types and formats and be subject to statutory and legally binding requirements and restrictions on what they must preserve and what the archive can or cannot make available. This means that it is difficult to find a one size fits all solution and the range of variables influencing a decision to develop, acquire or build the solution is highly ‘personalised’ to that organisation’s particular situation.

The level of specialisation will also impact the motivation of the User; as many Audiovisual Archives face very particular problems at a large scale there may be no other option but to take the route of developing one’s own solution. In situations like these, the Archive is operating in an environment where there may be no commercial upside or measurement available for expenditure by any traditional commercial model which will make it difficult to find commercial collaborators to share the burden of delivery.

While there are emerging business models that can be identified today that allow archives to recoup the cost of preservation through commercial exploitation of

digitised materials, this is not the standard in most Archives. In particular, Audiovisual Archives that are not the producers (or affiliated to the producers) of the content that they care for will not have such options available. Therefore the issue of cost is at the core of all solution procurement and such organisations are highly sensitive to price, as they operate on constrained and cyclical budgets.

There is a misalignment between the cyclical nature of funding made available to Audiovisual Archives in undertaking digital preservation which, by its very nature, must be a permanent undertaking. This can further affect how an Archive may procure a solution as, if there is a significant upfront capital cost in acquiring a solution or license, this may not align with available budgets.

In a scenario where a User can develop a solution to a problem through the use of open source software or the adoption of an applied research outcome, this can alleviate the upfront capital barrier but requires that the organisation also diverts technical resources to the development and integration tasks required, and be able to support the implementation going forward.

Therefore, the delivery of solutions to Archives in the form of subscription services will serve to alleviate this capital issue. Industry does appear to be moving in this way with the development of ‘cloud solutions’, which are provided in a SaaS (Software as a Service) or PaaS (Platform as a Service) commercial models; these are designed to enable Archives to access previously capital-intensive applications or functions such as transcoding, QA or storage in an on-demand or subscription environment. There does seem to be some movement by suppliers in opening up access to solutions in a “pay as you use it” model. However, for some important functions of the archive, the step to ‘the cloud’ is a difficult one to make. One example of this is in the outsourced storage of digital assets (masters). In this situation, the user is now reliant upon a third party guarantee of future availability and redundancy of data. The market will take a number of years for technological capability, pricing and comfort levels to harmonise to a level at which Users will be able to confidently outsource certain functions of their digital preservation workflow.

## **2.6 Licensing Routes**

Licensing is an area where the closer you are to a standard product license the simpler things can be. Licensing broader IP can be more complex and will typically require a specific legal document to cover such things as background IP, scope or use, warranties and commercial terms (which will be project specific). Approaches to licensing IP from research are explored in more depth later in this section.

## 2.6.1 General License Agreements

The main types of License Agreements (that cover commercial software licenses for products available to AV Archives) can be differentiated based on their structure. The first group of license types are the 'out of the box' type licenses, i.e. for software products that are ready to install and will not have a high level of bespoke integration or testing required.

The End User License Agreement (EULA [7]) is the most common form of license agreement for software products, particularly those used on personal computers and sold for single user applications. The EULA is the most appropriate type of license for applications that an individual (or a small number of staff) within an organisation might use, for example Video Editing Software. Typically a EULA will allow for the application to be installed on a single machine.

A site license is the most common form of 'enterprise level' software license, and allows for the distribution of an application across all machines that are in the user's network or on-site. The decision to opt for a site license is a balance between the cost per EULA and the amount of users on-site. At some point, the site license option will begin to offer value to an organisation. This decision may come into play in the integration of a media asset management system for an archive where desktop access to a digital archive will be provided via an application.

A duplicate grouping or sharing license applies where an organisation might wish for a range of users to have access to a particular application. A floating or concurrent license allows for the use of an application by a limited number of users at one time, useful in situations where a product or tool may not need to be available to all users at all times. Both concurrent and sharing licenses can offer a saving to an organisation seeking to use an application within certain operational constraints. Floating licenses can also apply to an IP address or range of IP addresses as opposed to users; in these cases, the software is licensed to the user to run on specific computer systems which are identified by their IP address. Such license terms are relevant to applications that are run off-site or within elastic computing environments.

The second group of licenses are relevant to scenarios where an organisation is interested in testing a research outcome that is not yet complete, or a software product that will require a high level of bespoke integration, further development or there are other integration risks that cannot be tested by means other than a test installation. These licenses are often referred to as trial licenses and can come in two distinct categories. A beta license is typically designed to foster bidirectional exchange between the developer and the user, in this case the researcher and the organisation implementing or productising the application. A beta license will allow

the user to test an application in its unfinished state with a view to feeding back the outcome to the research team to improve the application in line with user needs. Beta licenses will typically be limited in scope, of finite term and may exclude commercial terms.

A development licence is designed to enable an organisation or commercial vendor to further develop a research outcome. A development license will define separation between what is background IP and what will be created as foreground IP through the development process. The scope of the license, commercial terms and the criteria for the development may need to be negotiated and therefore the formation and agreement of a development license tends to be a more involved process for all parties.

### **2.6.2 Licensing of research outcomes**

The third group of license types covers situations where a license is granted to use a specific research outcome or application. Here, a payment is made to the licensor based on a specific usage or performance metric. Licenses of this type tend to be highly case-specific and typically cover situations where an organisation is licensing a research outcome from a research group for its own use, or where a commercial vendor seeks to productise or commercialise a research outcome.

Concerning the licensing of late stage applied research outcomes (IP) to industry we can broadly categorise three paths:

1. to an existing company who will commercialise the research output through productization,
2. to an existing entity who will use the research output for its own internal purpose,
3. to a new company set up to commercialise the research output through productization,

and three possible licensing models:

1. A license royalty linked to sales of a product or service dependant on the IP
2. A license fee linked to a benefit value for a company using the IP for internal use
3. A mixture of equity and royalty in return for a license

In each instance a different licensing model may apply, as described in the following sections.

### 2.6.2.1 To a vendor

In this scenario, the most common form of license will be a royalty bearing license. The license can be based on the projected value of the market for the product or service, or the projected increase in actual market value created through addition of the IP. The license royalty will be a percentage of the revenue achieved by the licensee. The following scenarios can apply:

- A license is paid based on gross sales of a product/service
- A license is paid on net profit from sale of a product (which requires a clear definition, as net profit/income/deductible costs may differ from one company to another)
- A license is bought out, based on projected sales (typically at a lower cost than the long term royalty may accrue, but provides the utility benefit of current cash to the licensor)
- Where a license is not bought out up-front the license will include projected royalties and may include penalties for bad performance (sometimes called a 'Use it or lose it' clause)

### 2.6.2.2 Direct to a user

In this scenario, the most common form of license will be a fee bearing license. The value of the fee will reflect the value of the saving or benefit to the licensee organisation. Consideration must be given to the development burden on the licensee to get the research outcome to operational level, and what support the licensor may need to provide the licensee in order to assist with ongoing usage and improvements to the implementation (support).

In this scenario, an upfront payment from the licensee may also be made to buy out the license or diminish the level of projected license fees.

A situation like this will typically arise for a licensor where the product market fit will not support a commercial intermediary, for example in a market where there is a small number of very large customers.

### 2.6.2.3 The 'Start-up' route

When licensing a research output to a new entity (i.e. a start-up or spin-out), the license can be a mixture of equity and royalty bearing. Such a deal is attractive to a start-up company as it can trade a value in its own stock in return for access to a valuable research outcome (IP). However, most start ups do not have much available cash.

If the start-up company is successful, the licensee will achieve a return in the event of a liquidity event (such as a venture capital investment into the company) which will drive the value of the company stock or the public offering of the company stock. The

trade off is that the licensee will pay a lower royalty going forward, as it has provided the stock as an 'upfront payment'. A balance needs to be made between the mix of equity vs royalty if this approach is taken.

Considerations for the company and the IP owner will include:

- What investment will be required in order to productise the research? Where will that investment come from?
- What is the projected market value for the product?
- What target does the company have for the sale of the product, and at what level must it deliver in order to retain the license?
- What profit can be achieved by the company through the supply of the product and what percentage of royalty will be achievable?
- If the company is acquired, will the IP be a factor in the acquisition and, if so, should the license agreement include provisions for the assignment of the IP to the company in such an event, and what premium will accrue to the licensor (sometimes called a 'drag-along' clause)?
- What will the scope of the license cover? Will it be broad, or limited to such constraints as industry, application, platform, geography?

In the case study included as an appendix to this report, the licensing of a research outcome to a start up is described in detail. This startup company, HS-ART Digital Services GmbH, was created specifically to bring research outcomes from EU research projects in the domain of film restoration to market. The company was created with the support of its parent company JOANNEUM RESEARCH, which has for many years been at the forefront of research into digital image and media processing technologies.

JOANNEUM RESEARCH participated in several Film Restoration projects during the 1990's and 2000's, which led to the development of licensable research outcomes that were commercialised via the startup HS-ART. JOANNEUM RESEARCH's continued commitment to this highly specialised research domain (and the sustained investment of the EC-IST and previous programmes) provided the runway required to bring the research to a level of maturity that allowed for its commercialisation through a specific purpose startup company. The arc of research and development spans over a decade in this example, which points to the need for continuity through generations of research funding and the commitment of industrial partners to long term support of collaborative partnerships with research groups.

In summary, the scale and specialised needs of audiovisual archives, the adoption of research outcomes calls for an involved, creative and flexible approach to licensing research outcomes. As many research outcomes will not be at a level of maturity that will fit with the traditional approach to solution acquisition (where clearly defined

products with specific license terms apply), the more bespoke approaches explained above (relevant to beta and development licenses) may provide a useful compass to practitioners or vendors who seek to evaluate research outcomes for potential licensing in future products or solutions.

#### **2.6.2.4 The Research Delivery Chain**

Figure 2.3 gives a visual representation of the route and decision points associated to the process of taking a research output and bringing it to a successful commercial product. There are a number of key milestones in this process, identified by the decision diamonds in the diagram, at which business decisions need to be made which influence the cost and investment of resources necessary to move to the next stage. At the outset of the process it is necessary to understand the commercial objective and the status of the research IP. At any of these stages it must be possible to conclude that the commercialisation is not viable. Once the viability has been established, investment is needed to continue to develop a product, and this is only likely to be forthcoming if a believable business plan has been produced. Only then can license negotiation be undertaken and the process enabled to move on towards developing the technological implementation, testing it in the marketplace as a beta release and ultimately launching the product commercially.

The flow diagram therefore illustrates the size of the task - a research output is never actually ready for commercial launch without significant investment - and also demonstrates that there are a number of key decision points and milestones that are encountered, at any one of which it may be determined that the commercial route is no longer viable, and re-negotiation is going to be necessary to avoid wasting investment on a product which will never ultimately be able to repay the cost of resources that went into creating it.

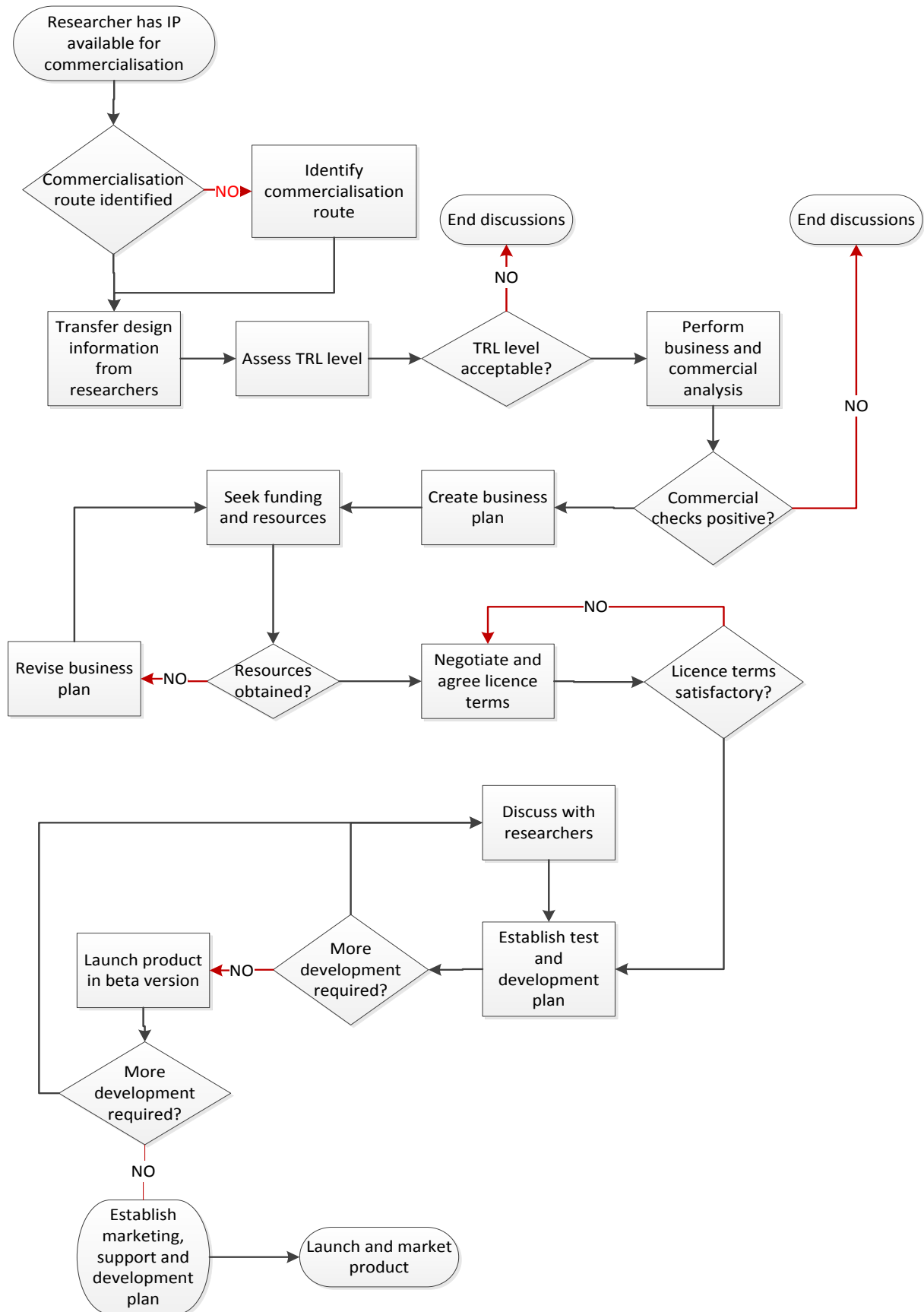


Figure 2.3 Licensing Path for Research Outcomes



### **3 Barriers preventing the adoption of research results**

This chapter discusses the barriers that prevent or hinder different stakeholders in adopting research results. These barriers may involve several factors, including technical, communicative, administrative, legal and financial issues.

The barriers discussed in the following sections are presented from the viewpoints of the various stakeholders. This does not mean that the barriers are always independent. The barriers faced by two interacting stakeholders may sometimes be two sides of one coin.

#### **3.1 End users**

In this section we analyze the barriers preventing the adoption of research results from the point of view of the “end users”.

##### **3.1.1 Identifying relevant research results**

One obstacle for end users is in knowing about relevant research results that may be useful for their domain, as the fora where these are presented may be quite far from their own domain. This issue can best be mitigated by involving brokers, service providers or vendors serving as the intermediate.

This kind of barrier can be analyzed as a “communication” failure of the “research output” and, very often, the dissemination to the “end user” is considered (wrongly) beyond the scope of research purposes.

##### **3.1.2 Usability and documentation**

Research results are often not mature enough to be used by end users, and may lack suitable user interfaces, documentation, error handling, etc. Research undertaken by Academies and Universities are usually strongly driven by scientific motives, and the software produced may not be well engineered or stable. Also the documentation is usually considered “wasted time” and left (if any time is left) to the end of research activities.

##### **3.1.3 Functionality**

There may be divergence between the functionality offered by the research result and the needs of the end user. Even if the divergence is small, this may hinder the adoption of the result or require further development to resolve the issue.

### 3.1.4 Portability, Integration

The research result needs to be embedded into the environment of the end user. This includes support for operating systems as well as integration with other I/O formats and tools used at the end user site (both standard and custom tools). For end users, the fact that a research output conforms to a standard reduces the risk of vendor lock-in and has the advantage that the technology has undergone competitive evaluation.

For sure, the increase in public awareness of public domain and open source development routes is paving the way for wider portability and integration for developed software. On the other hand, open source software usually requires higher skills for its installation.

### 3.1.5 Financial resources and costs

One of the main barriers to the adoption of new technology by Communities of Practice (CoPs) dominated by public institutions (e.g. higher and further education institutions) is related to the lack of human and financial resources. New investments follow a rigid structure within public institutions and various proofs and approvals are required before reaching a final agreement.

The lack of funds for adopting new technologies and tools makes them unaffordable. On the other hand, if tools have been developed within a private research project, it usually asks to contribute to the investment by some kind of fee.

### 3.1.6 Legal and licensing issues

Another barrier is the complicated nature of audiovisual rights, and the legal implications and cost of dealing with copyright clearances. Also the worldwide development of research and related software can imply rights (especially in Europe) and copyrights (especially in US). Moreover the concept of public domain has different meaning and legal implications across US and EU [2].

A further and more subtle issue related to licensing and legal aspects is the lack of information: many times the user is scared, not about the license associated to a tool or software product, but the lack of it. Especially in big companies, it is not allowed to make use of any tool or software if all the associated licenses are not clear, because the risk of legal infringement is heavier than the benefits introduced by the adoption of the tool.

### 3.1.7 Organisational issues

In educational organisations, there is often no central strategy for digital preservation and no buy-in from senior management. The individuals or micro-teams involved in the collection, production and curation of AV educational materials have to deal with

the internal rigid administration and IT departments, who often make decisions without thinking of scalable solutions or involving end users (who have the knowledge of audiovisual media and workflows).

Departments are very often working separately, and many difficulties are experienced when trying to migrate technologies that have already been selected and adopted by one department across department boundaries to be adopted elsewhere in the organisation. Paradoxically, this can occur even more in Research Institutions, where the competition between departments can be much higher than in the commercial context.

## **3.2 Software vendors**

### **3.2.1 Licensing issues**

From the point of view of software vendor, the presence of licenses associated to technologies and tools can result in a limited revenue and limited exploitation of them. Especially subtle in the open source domain are so-called “viral licenses” [3], that propagate over software components built on top of others and forbid further different licences and usage/redistribution.

### **3.2.2 Code quality, maintenance**

A concern for software vendors is the code quality of research results, which were created to prove a method rather than with requirements for production quality code in mind. Of course, this issue can be resolved, but often at a significant cost.

Another issue is maintenance of the code, which may include functional extensions, bug fixes and adaptations to new operating systems, frameworks, etc. It is critical that the staff at the research institution is available long term. This risk is higher for universities than applied research institutions, as they typically have a higher fluctuation among their staff (e.g. PhD students, postdocs).

One key point (that is explored further in the case study included at the end of this report into the adoption of research outcomes by the company HS-ART Digital Services GmbH) is that the quality of the research outcome must not only be of a high quality but also very specific in function. Within the digital film restoration market, service providers and users will use different tools that provide the best result for a specific function rather than use a single system that provides a high number of average quality functions.

### 3.2.3 Integration and standards compliance

There are several issues around integration and standards compliance, which may cause considerable effort and are also related to the maintenance aspect. The integration issues concern support of operating system, frameworks, I/O formats, as well as the actual interfaces of the vendor's own software, into which the results are to be integrated. The efforts may be large, and may render the integration of the research result not economically viable.

A related issue is compliance to standards. Standardisation processes aim to establish interoperability for a specific technology area, selecting from different solutions proposed. Selected solutions are documented in a public specification document, so that implementations can be made by third parties. Achieving standards compliance for a research result is comparable to achieving integration into a specific system. However, if standards compliance is considered early on in the development, standards are a means to reduce integration efforts into specific systems, e.g. by following interface standards such as FIMS [1].

Research outputs are also important inputs to standard development processes. This includes proposals for new technologies as well as scientific comparison and evaluation of different technologies for a specific application domain or data set. Clearly, standardisation is driven by industry needs, and in many cases influenced by the commercial interests of the stakeholders involved. For industry, the standardisation process provides an opportunity to see comparable research results from other workers relevant to their application areas.

### 3.3 Service providers

In contrast to software vendors, who will integrate results in their tools, service providers will typically require a tool or service to be used. Thus, the barriers encountered come closer to those of end users. The main difference is that the users of the research results at the service provider will usually be a small group of potentially better skilled users.

Hence the high level of expertise of service providers can overcome any barriers due to:

- difficulties in finding tools and technologies (because service providers are well experienced in finding such)
- their lack of documentation
- difficulties in portability and integration

The remaining barriers from the point of view of service providers are those introduced by legal and licensing aspects, because some licenses do not allow

further development of the tools (and hence their customization tailored to the client needs).

Concerning the “limited functionalities”, this can be considered a barrier at the beginning, blocking the technology selection. It is less dramatic if the lack of functionality is discovered after a preliminary evaluation because service providers are reasonably able to implement the missing parts and components.

### **3.4 Media owners**

Media owners suffer the same barriers to technology adoption as described in the section dealing with the “end user”, because media owners are eventually “end users”.

A further barrier that can be in place on the media owner side is the technological infrastructure he or she is currently using. For instance, broadcasters are mostly embracing two main technologies all over the world right now: Sony and Panasonic. If a media owner has a Sony environment he has to deal with HDCam’s and MXF with D10, and probably is most interested in technologies supporting these formats rather than others, even if other tools are providing the functionalities they are looking for, but in the other environment.

### **3.5 Researchers**

This section analyses barriers preventing the adoption of novel technologies, tools and standards from the point of view of Researchers.

As described below, very often Researchers are themselves creating barriers to the diffusion of their results, limiting the adoption of outcomes. Somehow they are failing to promote their results and make them available outside the research environments where they have been experimented on. The following sections point out some main issues preventing the adoption of research results, but it is also important to highlight that we must create a common awareness among researchers and scientists that every time an outcome is left on the shelf it is a failure of research and a failure in our collective cultural heritage, that cannot benefit in the future from the effort already spent in performing specific tasks.

#### **3.5.1 Funding exploitation of research results**

A well known barrier for researchers is bridging the chasm between a promising research result and a prototype that is sufficiently mature to be provided to potential users or integrators. Research funding typically ends at the stage where the method is proven to work on a limited data set. At this stage, there is usually a set of experimental devices and/or software tools, that can be applied by a researcher to

new data. However, the research result is often not yet suitable to be used by the potential users or integrators. The lack is mostly not in the actual core functionality, but in usability (where interfaces to end users are involved), support of I/O data formats, handling of error conditions, availability of end user documentation, etc. Although secondary to the main functionality, these aspects are crucial for exploitation of the result, even if there are integrators or brokers involved.

As these lacking aspects are often tightly coupled with the core of the research result, the improvement of the research result towards exploitation cannot be easily outsourced, but needs the involvement of the research team. Obtaining funding for this stage is a very difficult issue, as it falls outside the scope of most funding schemes and, due to the status of the research result, it is hard to get investments from potential customers/integrators for continuing the work.

These barriers not only affect commercial exploitation, but also affect the making available of research results as open source projects. Due to the lack of resources to improve support for platforms and interfaces, user interfaces, documentation, etc, often an open source project is created by providing the research results “as is”. It is often not possible for the community to take over the open source project at this stage, as know-how is missing and considerable efforts for improving and completing the project are required.

### **3.5.2 Efforts for evaluation experiments**

Clearly, archives are interested to know how well a research result will work for their specific problem or on their data. Thus, before continuing towards exploitation, experiments on specific data sets are required. As discussed above, the resulting tools are usually not in a state to put them in the hands of end users, thus these experiments need to be run by the research group that developed the results. There may be considerable efforts associated with these experiments, often more on the data integration side, such as supporting specific data formats, converting and preparing data, etc. There is an issue of obtaining sufficient resources for performing such experiments.

### **3.5.3 Portability and integration**

Research results need to be integrated with the environment of the end user or software vendor. This may require porting to a specific operating system, supporting specific programming languages, using specific frameworks and libraries, and integration with specific software. Adherence to standards, if they are available, can reduce the efforts for a specific integration, but achieving standards compliance can be a large effort in itself.

In general, there is the issue of effort for integration. In specific cases, there may be even stronger restrictions such as (not) using a specific base technology due to company policies.

#### **3.5.4 Exclusivity issues with selling/licensing IP**

Research results are, in most cases, not only the output of a single project, but based on years of work in the research group, often reusing and further developing results from previous research activities. This becomes an issue when exclusivity is required by the customer. Some companies have the policy of requiring the IP of technologies important for their products to be fully under their control, which only leaves the option of buy-out of the IP. The IP to be sold/licensed may include basis components that have already been used in other contexts, and may even be part of other exploitation agreements. In addition, such exclusivity requirements may limit future research.

#### **3.5.5 Diverging exploitation interests in collaborative research projects**

A particular issue with collaborative research projects is the diverging exploitation interests of both commercial and research partners. In many cases exploitation does take place for specific research results between specific groups of partners. While this is the case rather for tools solving specific problems, exploitation of comprehensive solutions, frameworks or systems is often not successful, as this would require a joint exploitation strategy of many stakeholders, both on the research and on the commercial side.

#### **3.5.6 Convincing IT and purchasing departments**

The contacts to potential end users are, in most cases, with the users directly affected by the problem to be solved, or – in particular for larger organisations – with an in-house research/development/innovation department. The research is, in many cases, performed in close collaboration with these contacts and, if the results are promising, the representatives of the organisation recognise the potential value of the solution and are willing to adopt it. However, there might be barriers within the organisation that make this process difficult. Other stakeholders in the organisation, such as IT and purchasing departments, tend to minimise their risk by selecting proven products, with a fixed price. This generally does not hold for research prototypes to be introduced, which have related costs for integration, and are by their nature not yet mature, thus having risks of failure and interoperability issues.

#### **3.5.7 Recovering investments in funded research projects**

Public research funding agencies ask increasingly for the publication of research results under open source/open access conditions. Whilst there is some justification

for this, due to the use of public funding, some of the partners in a research project are not fully funded, but need to invest their own resources (be it part of the actual costs, overhead cost, etc). Thus, the publication of research results under open source licenses must still be accompanied by a business model around these results, which allows recovering the partners' own investments.

### **3.5.8 Adoption of standards**

The contribution to the development of standards is also a route for exploiting research outputs, and making them available to a larger community. The successful completion of a standardisation process does not necessarily mean that the standard will actually be widely adopted. Like for other research results, there are a number of barriers that may prevent the adoption of the standard. We discuss specific issues for standards in the following sections. For a more general discussion on standardisation processes, and existing standards and gaps in the digital preservation domain, see D4.2 - "Interim Report on Audiovisual and Preservation Standards".

#### **3.5.8.1 Complexity**

The stakeholders in the standardisation process sometimes have conflicting requirements from possibly different application areas. This makes it difficult to select technology that fits all needs. This issue sometimes results in standards that try to fit all these needs by increasing the complexity of the solution, thus increasing effort to learn, understand and implement the standard. This issue has been encountered, for example, with MPEG-7 or MPEG-4 LAsER (pt. 20), which has resulted in few available implementations and slow adoption. The definition of profiles, which select a subset of the standard for a specific application area, is an approach successfully applied to overcome complexity.

#### **3.5.8.2 Lack of implementations**

The availability of tools implementing a standard is crucial for its adoption. There are typically reference implementations that are created during the standardisation process for testing purposes. However, these implementations often share the properties of research results, i.e. while they are functionally complete, they lack usability, documentation and interfaces.

#### **3.5.8.3 License policy**

The license policy can have a significant impact on the adoption of a standard. If there are license fees required for components for which this hinders viable business models (e.g., for video decoders rather than only encoders), this may prevent wide



adoption of the standard. Furthermore, if there are fees required for getting access to a standard, this may hinder adoption.

## 4 Conclusions

This report has documented the current status on technology take-up from the point of view of Communities of Practice (CoPs), investigating the business, economic and licensing routes and analysing the most common barriers against the adoption of novel technologies, tools and standards.

Initially the report has considered the various stakeholders and their motivations, looking at the three main groups of Researchers, Practitioners and Vendors within the audiovisual archive marketplace, and how these stakeholders can approach solution development collaboratively or individually. A description of the various forms of licenses that can apply where a user wishes to acquire a mature solution has been provided, and further to this we have outlined a number of stages and scenarios to explain ways that late stage research can be transferred into application, either by a user or a commercialising party in the form of an existing company or a start up business.

The second half of the report focussed on the barriers we have against the technology take-up. As described in Chapter 3, there are many barriers preventing the adoption of research results in our Communities of Practice. The report has tried to analyse and investigate some of the main issues limiting the adoption, suggesting potential good practices for overcoming them. In order to provide a quick summary, Figure 4.1 shows the aforementioned barriers for research results, in a common flow of outcomes production.

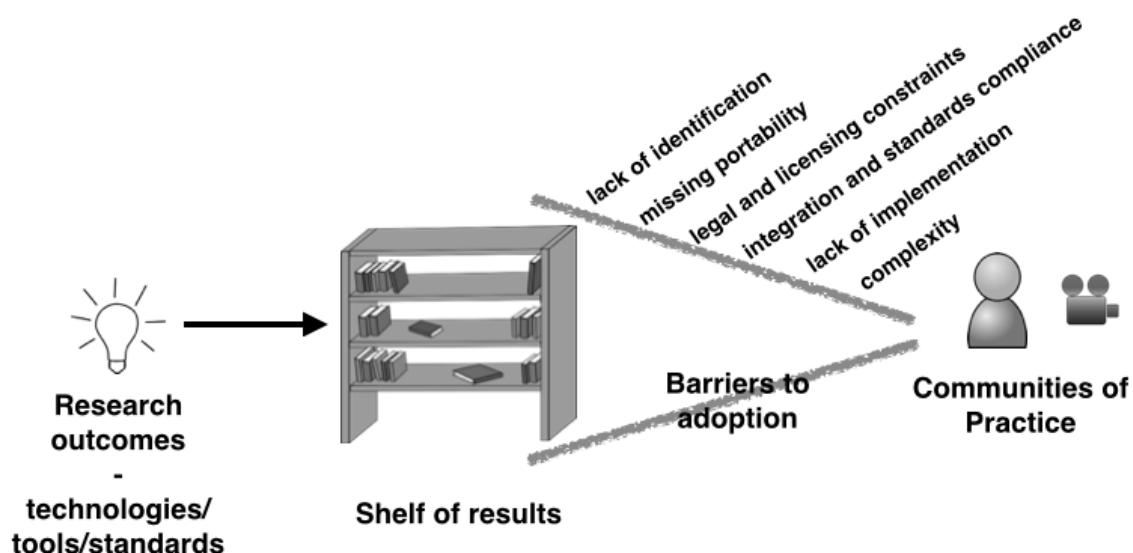


Figure 4.1 - Barriers to adoption of research outcomes, as described in Chapter 3

Ideas and novel technologies, tools or standards (left side) are translated into research outcomes that are added to the results shelf, at various different levels of maturity.

As already pointed out, every result left on the shelf is a “research failure”, because it is not allowing an exploitation by anyone of the effort spent in performing the related research. Many business models have been analyzed in the past, in order to disseminate the shelf of results, and many projects providing at least the index of outcomes have been set up. Chapter 3 has pointed out some of the main barriers limiting the adoption and the diffusion of research outcomes. Figure 5.1 reports at the top some of these, including:

- lack of identification (impossible to search and find the result),
- missing portability, which means low IRL - Integration Readiness Level [4] and also low TRL - Technology Readiness Level [5]),
- legal and licensing constraints, such as policies, copyrights, patents, and the like,
- integration and standards compliance, that implies broken interoperability and lack of interfaces (usually the matter of standardization),
- lack of implementation, especially in research contexts - prototypes are wrongly considered to be final results, when they are missing several necessary functionalities,
- complexity, because as can be easily guessed research aims at finding fast solutions, ready to prove analysis and theories, leaving aside good user interfaces, friendly use, documentation and manuals: that introduces huge complexity in the adoption.

As is well described in Chapter 3, the barriers listed above are just some of the potential obstacles to adoption of research outcomes. Figure 5.1 shows these barriers as a funnel within which a lot of good research results will die or be left out, unable to cross barriers and reach the user.

There are many pieces of advice provided in the detailed description in Chapter 3, in order to figure out how to limit these barriers. Moreover, looking at the picture, we can introduce the role of the “broker” (described in Section 2.4.5 - The role of the Broker) as the “gatekeeper”: the person in charge of transferring the research result into a production (end user) environment. This role has the responsibility to

understand the users' needs and be continuously updated with the latest research performed, with a good knowledge of the item left on the "research shelf".

Within the Presto4U project, the role of identifying new technologies and research outcomes will be taken by the consortium members of workpackage 4, and the information identified through this work will be placed in registers for standards and software tools which form core components of The Market Place. The role of the broker is played mainly by the project as a whole and will link with the PrestoCentre [8]. The Presto4U project gathers together a number of different Communities of Practice and through a structured process of investigation builds a clear understanding of their needs, suggesting the most appropriate solution and related information on how to use it, in order to limit or overcome the barriers to their adoption.

## Glossary

| Term | Definition                   |
|------|------------------------------|
| AV   | AudioVisual                  |
| CoP  | Communities of Practice      |
| EULA | End User Licence Agreement   |
| HD   | High Definition              |
| IO   | InputOutput                  |
| IP   | Intellectual Property        |
| IPR  | Intellectual Property Rights |
| IRL  | Integration Readiness Level  |
| IT   | Information Technology       |
| MPEG | Moving Picture Expert Group  |
| MXF  | Material eXchange Format     |
| PaaS | Platform as a Service        |
| QA   | Quality Analysis             |
| SaaS | Software as a Service        |
| TRL  | Technology Readiness Level   |

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## **Annex: Case Study DIAMANT-Film**

This section provides a brief overview of what DIAMANT-Film is today, gives a historical reflection about R&D projects which lead to DIAMANT-Film and provides more general conclusions on factors relevant in respect to the professional exploitation of R&D outcomes.

### **1.1 *DIAMANT-Film today***

DIAMANT-Film is a set of software products for fully automatic, semi-automatic and interactive digital restoration of film content. It includes tools for the restoration of single frame defects (dust, dirt, blotches, mould, bacteria, hairs), scratches, instabilities or shaking, local and global colour and brightness instability like flicker, film grain noise, vertical line scratches and for destroyed images or parts of images (bad splices, tears, burned frames, warped images, dead pixels), etc.

An easy-to-use interface and restoration modules offer a flexible solution to optimize the workflow in the digital restoration process.

DIAMANT-Film has been on the market as a product for more than 12 years, and is used by over 150 clients worldwide at film archives, post-production houses, studios and laboratories. Detailed information on the different DIAMANT-Film products can be found at <http://www.hs-art.com/>.

### **1.2 *Historical evolvement of R&D projects lead to DIAMANT-Film***

#### **1.2.1 R&D projects**

##### **LIMELIGHT**

The EUREKA project LIMELIGHT (<http://www.eurekanetwork.org/project/-/id/1041>), starting in 1994, was the first international project with the goal to develop “A new generation of fast and high resolution digital system to scan, process and print cinema quality images”. For processing of digitised moving image content a first set of restoration algorithms (the so-called LIMELIGHT film restoration software) have been developed which allowed the restoration of single frame defects (like dust and dirt), film grain noise, image instability, flicker and the interpolation of severely damaged frames. These restoration algorithms were implemented as command line tools which could be parameterised by an expert, according to the needs of the restoration job. The runtime on standard PCs was quite extensive, only off-line processing (typically rendering overnight) and iterative re-parameterisation was possible. The long processing time, the lack of an intuitive user interface and the limited functionality prevented from commercial exploitation at this stage.

## FRAME

The ESPRIT project FRAME<sup>1</sup>, initiated in 1997, aimed at parallelizing the LIMELIGHT film restoration software for distributed systems by using the Message Passing Interface (MPI) and to do pilot installations and evaluation of the restoration software. Due to parallelisation the runtime of the original LIMELIGHT software could be reduced by a factor of 10. This allowed the first time to setup a restoration system, where the computation time alone was not anymore the critical factor.

Pilot installations and evaluations at end users site with real film restoration projects showed that operation is still very much limited by lack of proper user interaction capabilities, as only command line tools having very simple user interfaces without any direct visual feedback on restoration results have been available.

During the FRAME project a spin-off company from JOANNEUM RESEARCH has been set up (HS-ART Digital Service GmbH – HSA in the following), with the goal of being a technology integrator and marketing company. In course of that also the LIMELIGHT software was one major technology to be marketed.

## DIAMANT

The EC IST project DIAMANT starting in the year 2000 had the goal to develop a general “Digital Film Manipulation System” with a first application of digital film restoration.

Based on a general middleware developed for accessing digital film data and for describing manipulation operations on digital film (a job) two applications have been developed. An application allowing the management of a large set of digitised film and related restoration job definitions (digital film import, export, restoration job management and distributed offline rendering of restoration jobs). A second application has been developed allowing the interactive definition and rendering of a restoration job for a digital film. This was the first time that an operator could almost immediately see the results of applying restoration modules and adjusting parameters. Extensive evaluations in real restoration projects have been carried out by end user partners. Heavily improved usability resulted in a significant reduction of the operator time required.

At the time the DIAMANT project finished these applications were the basis for the launch of the product DIAMANT-Film by HSA, who was also partner in the DIAMANT project.

## PrestoSpace

The EC IST project PrestoSpace starting in 2004 had the objective to provide technical solutions and integrated systems for complete digital preservation of different kinds of audiovisual collections. Within the restoration work area of the project a set of DIAMANT-Film related restoration algorithms have been prototypically developed, i.e., solutions for film grain detection, film grain synthesis

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<sup>1</sup> <http://www.vcpc.univie.ac.at/activities/projects/FRAME/>

and line scratch removal. These prototypes were the basis for new DIAMANT-Film modules.

### **Dust-NG**

The Austrian national R&D project Dust-NG starting in 2010 had the goal to develop novel algorithms and software tools for reliable detection and removal of single-frame defects like dust, dirt, blotches and hairs. The development of a new solution reflected the requirements to do restoration in even higher resolutions (2K, 4K, and 6K) in higher quality and with higher degree of automation. The Dust-NG prototype became the bases for a new DIAMANT-Film dust and dirt module.

### **DAVID**

The EC IST project DAVID, started in 2012, analyses (for digital AV media) the origin of potential damage and its consequences on the usability of content. The project aims to detect and restore damage that has already happened, and to develop strategies for avoiding future damage. DAVID is developing prototypes for the detection and restoration of DigiBETA dropouts, digital sensor noise and a group of field order defects. These DAVID prototypes are planned to be the basis for future DIAMANT-Film restoration modules.

## **1.2.2 Licensing of R&D project results**

Within the different collaborative and partially funded research projects described in section 1.2.1 the creator of the research results remained the owner of it. Many research results relevant for DIAMANT-Film have been created and are owned by JOANNEUM RESEARCH, but also other partners including HSA have created research results relevant for later DIAMANT-Film exploitation. Research results owned by JOANNEUM RESEARCH have been licensed by HSA for usage and exploitation within DIAMANT-Film. DIAMANT-Film is exclusively marketed by HSA.

## **1.3 Conclusions on factors relevant in respect to the professional exploitation of R&D outcomes**

### **1.3.1 Continuous involvement of end users**

The involvement of end users and service providers during all projects was essential to the success of DIAMANT-Film research. They provided concrete requirements, and also provided specific feedback based on evaluation of real restoration jobs. They are professionals in their application domain (archive restoration, post-production restoration) and were able to anticipate how new technologies (in this case digital film restoration) would change their workflows and business.

### **1.3.2 Continuous involvement of industry**

There is an active involvement of industry partners needed in research projects.

Industry partners need to learn about commercial parameters of certain technological solutions. In the case of DIAMANT-Film, major factors for a commercially attractive restoration service are the usability of the system, the quality of the algorithms and the speed of processing.

There has to be a mutual understanding between research organisations and industry. Research institutions have to understand that the aim of the industry is to have products to solve the problems of their users. The industry has to understand research is only partially predictable and that approaches followed in research might not yield the results expected.

### **1.3.3 Technically flexible solution**

In order to allow fast adaptation of the film restoration products to the needs of customers, DIAMANT-Film was designed from the beginning on (mid 1990's) as a software solution.

This was a clear advantage compared to competing hardware based products, as it allows the fast extension and update of restoration functions (by a plug-in architecture) and I/O functions, e.g. the support of new file formats for different resolutions (SD, HD, 2K, 4K, 6K).

The requirements on special hardware should be as low as possible; DIAMANT-Film uses inexpensive hardware (off the shelf Windows based workstations and standard disk storage or SAN). Today only GPUs are required as special hardware; even this hardware is widely used and further developed for the gaming market.

### **1.3.4 Highest research quality and understanding**

DIAMANT-Film provides a set of restoration functions, each of which are dedicated to the restoration of a specific defect. The technology developed for a specific defect must be able to robustly detect and restore a defect, and needs to solve the problems of real users and real restoration projects. Service providers and users often use different restoration solutions available on the market; for each specific defect they use the product which yields the best restoration result for that defect with the least effort. Therefore in the restoration market it is essential to provide highest quality functions rather than a high number of average quality functions.

### **1.3.5 Creation of a sustainable business with professional solutions**

The creation of professional solutions in the AV preservation domain (and DIAMANT Film is an example for this) is a long term process. This process involves often a number of research projects in order to understand the problem and to prototype solutions, and involves a second phase in which, based on prototypes, a high quality, full featured product needs to be built. Both phases (especially the second one) require a high amount of financial resources, therefore it is essential that

product providers are able to build a sustainable business with their products. This can either be reached by product licensing or, in the case of open source solutions, by offering services like integration and support.

### **1.3.6 Continuing R&D efforts**

The case of DIAMANT-Film proves once again that transfer of research results into products is a long-term process. This can only be done in a process where resources for continuing the development of early promising research results are available.

In the preservation domain, both solution providers from the industry as well as end users are under constant strict cost pressure, so that they are in most cases not able to invest into further development of early prototypes. The reason that DIAMANT-Film is still successful on the market today is also that research results have been fed back into the product over the years, resulting in new functionalities, better support for interactive work, etc. Early recognition of users' emerging demand can create the case for interesting and rewarding research efforts, which can then be successfully exploited to improve the product.