Individual Giving to Support Cultural Heritage

The Future of Museums in the Digital Age: New Models of Access and Use of Digital Collections

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Abstract The aim of this paper is to investigates how the transition to digitization and the Internet are affecting the management of museums' digital cultural collections and what are the current challenges and opportunities in such new context. Drawing from the economic literature on information technology and from a selection of current initiatives in the cyberspace the authors provide an analytical framework which help identifying the main emerging models for access and use of digital collections and assessing the main challenges for museums as to their role of leading providers of authoritative content, the profitability of digital collections and the adoption of new metrics to assess their social impact and public mission.

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1. Introduction

The paper attempts to analyze how technological innovation is reshaping the role and mission of museums as producers and distributors of cultural content. In particular, the paper investigates how the transition to digitization and the Internet are affecting the access and use of museums digital cultural collections and what are the current challenges and opportunities in such new context. While much of the literature related to technological innovation and museum management has focused on the impact of digital applications on museum exhibitions (i.e. vom Lehn and Heath 2005; Thomas and Mintz 1998) or on visitors' virtual experience (Minghetti et al. 2002; Peacock and Brownbill 2007; Soren 2005), less attention has been devoted to understanding what are the implications for museums in managing their cultural collections in the digital era.

As stewards of cultural materials, museums have always managed access to and use of their collections, but the digital revolution is radically changing cultural consumption and production patterns, obliging museums to re-think how they relate to their audiences as users of cultural content. For instance, digital technologies have the potential to allow museums to achieve a step increase in the access and reuse of their collections. At the same time, low reproduction and transmission costs of digital content are likely to threaten the economic

control by museums over their intellectual property assets and to erode their authority as leading players in the authenticity, integrity and contextualization of artworks and cultural heritage objects. As a result, museums face today a clear tension between favoring increased access and strengthening control over their digital collections. On one hand, the increased opportunities to open up access to digital images would potentially enhance economic and social value through their dissemination and re-use. On the other hand, control over their digital collections would potentially allow museums to generate new revenues in information markets and to maintain their position as gatekeepers of authoritative and trusted cultural content.

With this perspective, the paper addresses two distinct but interrelated aspects. First, drawing from the economic literature on information technology we contextualize digital art images within the information economy and describe the main shifting or emerging patterns in the production, distribution and consumption of digital cultural collections as information goods. Second, by assessing a selection of current initiatives, we single out a typology of four emerging models for access and use of digital images of artworks, namely online display, proprietary licensing, open licensing and user-generated art images. Arguably, these represent the main responses by cultural organizations to changing users' behavior, production and transaction costs in the cyberspace and provide different balances between opening up access and maintaining control by museums over digital cultural collections.

While more in-depth studies would be required to better understand the viability of the different models highlighted, the paper contributes to the culture and art management literature by providing an analytical framework which helps assessing the main challenges for museums in developing strategies for the access and use of their digital collections.

The paper is organized as follows: Section 2 describes the main economic characteristics of digital images as information goods and the impact of digital technologies on the models of access and use of museums cultural collections. In section 3 we categorize and analyze the main emerging models of access, dissemination and use of digital images of museums cultural collections. Section 4 discusses the main challenges and opportunities for museums in managing their digital collections, while section 5 concludes suggesting new research developments.

2. Paradigm shifts in value creation for museum collections in the digital age

The digitization of cultural collections, combined with the increasing capacity of storage and Internet access to digital information, is causing a rapid change in the traditional models of using, managing and accessing knowledge and information related to cultural heritage and artworks.

The traditional model of museums was based on a physical collection of objects, publicly funded and publicly accessible in a building. The core mission of museums was to preserve, catalogue and develop the collection, to provide access to it so that to transmit national and global culture to the general public and to make material available for research (Alexander, 1983; Lewis, 2011). In this view, cultural institutions have been deemed repository and producer of knowledge based on the preservation of collections of physical objects. Museums indeed organize and interpret the information embodied in the cultural objects and have become educational facilities, a source of leisure activity and a medium of communication of cultural content. The intangible goods produced by cultural institutions thus represent an added value to the physical collection.

Although there have been significant technological advances, the forms of managing the access to and use of cultural materials by museums have fundamentally remained the same throughout the time. Cultural objects were typically made accessible to the general public directly through in-house exhibitions and to the scholarly audience through the physical access to the object. Further, the control over the distribution and use of images was eased by physical and technical constraints. When the distribution of reproductions of art works was accomplished with film-based slides, transparencies, and printed images, obtaining an image generally required moving a physical object, a film or a paper-based image from one place to another. Although images, once acquired, could be duplicated, to some extent the quality of the reproductions has been always less than the quality of the originals (Hamma 2005).

2.1 Economic Background

The transition to digitization and the widespread dissemination of networked digital information is likely to transform the way knowledge related to physical cultural collections is produced and managed both by museums and users.

From an economic viewpoint, digital cultural collections may be commonly analyzed as a specific kind of information associated with physical artifacts that is collected, produced, stored and disseminated by cultural institutions in digital format. Digital cultural collections have therefore some specific economic properties related to information goods and their markets (Shapiro and Varian 1999).

- Supply and demand side economies of scale: moving the reproductions of their collections from the analogue to the digital world, museums face substantial fixed and sunk costs in the digitization process, but then the cost of reproduction and

distribution of digital images is low and close to zero. This cost structure – relatively high fixed costs and low marginal costs - generates return to scales (average cost decreases with scale) in the supply of information goods and is likely to favor the creation of natural monopolies which allow producers to recover fixed and sunk costs through pricing above the marginal cost or through price discrimination. At the same time, information goods present strong network effects in consumption, as demand depends on how other users share, consume or purchase the same good. This means that demand shows scale effects and information good producers and distributors are more likely to acquire monopolistic positions in the information market. Once a firm has established market dominance with a particular product, it can be particular hard to unseat it.

- Public good characteristics: digital images of artworks have public good characteristics, that is they are both non rival and non-excludable. Non-rivalry means that consumption of the good by one person does not reduce its availability for others. Non-excludability means that, if the good is made available to some, others cannot be prevented from consuming it. While non-rivalry is a property of the good itself, non-excludability is rather a social choice, depending on the effectiveness and cost of technological and legal restrictions on information transfer.
- Experience good: both in the analogue and digital format, the cultural content and the information conveyed by artworks may be considered as a form of experience goods in the sense that a consumer cannot verify their quality or value in advance, but only by consuming the goods. For example, the value of accessing a particular artwork to any individual depends upon a complex set of connections with his/her knowledge acquired in the past, such as that of the history of art, of the social context in which

the artist worked, of physical theories of light, color and perspective. The digital revolution seems to have amplified the experience goods problem. As more and more information are produced in the digital environment, users have access to a plethora of content. Thus, to experience such content, the new real scarce resource and valuable commodity is the contextualization and authentication of content (Pantalony 2007).

- Low transaction costs: the digital environment lowers transactions costs in absolute terms as supply and demand can meet almost ignoring space and time barriers. In a similar vein, digitization of cultural collections has strengthened the quality and quantity of available object images and cataloging information, so that images could be quickly located and processed for distribution and licensing to both internal and external customers. This is likely to enhance museum image-licensing models as well as to improve traditional activities such as collection management, curatorial practices and scholarly research.
- Low production cost of information: while it is recognized that information goods show higher fixed costs relative to the marginal costs of reproduction and distribution, it is equally acknowledged that the digital environment has also empowered (former) users with production tools of digital cultural content that used to be an exclusive of professional producers. Since digital images are easy to reproduce, aggregate and transmit, they have an high potential for use and reuse in the networked digital environment. Web interfaces can provide tools that allow users to publish copies of digital images, combine them in different ways, create new juxtapositions or links, and explore scholarly text-based information about individual images, artists and subjects portrayed (Besser 1997). Such a “wealth of networks”

(Benkler 2006) is likely to generate not only an enhanced access to digital images of artworks, but crucially a new commons-based knowledge on museum collections by users of the general public.

- Long tail effect: a much debated corollary of low transaction and digital inventory costs is that niche products (i.e. products that have individually low sales volume) can collectively represent a market that is as profitable as the one for best-selling products (Anderson, 2006). While the long tail effect has been particularly studied in online retail services (i.e. Brynjolfsson et al. 2006; Elberse 2008), such pattern may also occurs for museums' digital collections which are usually characterized by a handful of popular works and a majority of less known but equally valuable niche cultural objects.
- Complementarities and indirect appropriation strategies: while direct appropriation refers to selling access to information goods at least at a price sufficient to cover production costs, indirect appropriation strategies encompass any means by which the producer can obtain a benefit from producing the information other than sale of permission to access it, including the control over complementary goods (Benkler 2002). For instance, although information goods have public good features and are easily subject to unauthorized reproduction, in the economic literature it is commonly recognized that under specific circumstances the increased availability or consumption of a digital information good may positively affects the value or the demand of another complementary good for which access can be controlled (Peitz, and Waelbroeck 2006). If an agent controls the latter resource, he may partially or totally reap the effects of an increased supply of the first asset. As a result, the increased accessibility and use of digital cultural collections may

increase the value of other commercial products and services related to a museum physical collection or exhibitions.

2.2 Patterns of Use of Digital Cultural Collections

Such economic properties have some profound implications in terms of generation of new patterns of use and business models for the access, dissemination and use of digital cultural collections.

Firstly, low transaction and production costs provide a new set of opportunities to online engagement with arts and culture. On the one hand, the long tail effect could make it profitable for some big institution to digitize part of its stock and let some obscure collections meet their dispersed (niche) demand. On the other hand, digital technologies have triggered the demand for users to share, aggregate and link digital content across institutional boundaries. As most collections represent only part of the corpus of any single artist, subject area or era, the need to pull together cultural resources from across many institutions may be seen as an intellectual imperative for enhancing users' experience to museums collections (MTM London 2010; Tanner 2004).

Secondly, as technology for digitization and digital distribution takes command, new technology-leading information providers different from established museums are gaining larger importance in the distribution of digital cultural content. This occurs because information goods, characterized by strong supply and demand-side economies of scale favor aggregation dynamics and strategies made possible by the low-cost digital processing and storage (Shapiro and Varian 1999; Bakos and Brynjolfsson 1997). Learning effects frequently

reinforce this process and the long tail effect may offer new sources of revenue to the owners of the largest collections.

Thirdly, the digital environment is dramatically making obsolete the traditional image-licensing models (both for commercial and non-commercial use) set by museums. For instance, while traditional licensing models require complex procedures and typically tailored on the demand of art publishers and scholarly researchers, the reproduction of digital images of cultural collections entails new types of web users and demand for a faster dissemination of authoritative digital content (Bray 2009).

Finally, drawing from the current debate on opening up access to Public Sector Information and Content by government and public bodies, public and non-profit museums that participate in publicly funded digitization projects are increasingly prompted to adopt policies and strategies for making their digitized content available with limited economic, technical and legal barriers to widen its diffusion and enhance users' cultural and educational experience (OECD 2006). In this case, the rationale is that as the costs of disseminating and accessing information have declined, the transactions costs associated with charging for access to information, and controlling subsequent redistribution have come to constitute a major barrier to access in themselves. As a result, the case for open access and flexible re-use of digital images of artworks in the public domain may generate social benefits in making such digitized information available to the public for both commercial and non-commercial purposes (Quiggin 2009).

Given such emerging patterns it is evident that, while digital technologies have strongly enhanced access to museum collections both in quantitative and qualitative terms, it is by no means straightforward how far museums will achieve to manage and benefit from the new added value generated by the opportunities of the digital environment. To answer this

question it is necessary to focus on the evolution of business and organization models for the access to and re-use of digital images of museum collections.

3.Emerging models of access to and use of digital collections

In this section we draw from a selection of examples to identify and analyze four emerging models for access to and use of museum digital collections. Arguably, these represent the main current business and organizational responses by cultural institutions to the changing economic and technological conditions triggered by digitization and the networked environment. The analysis is by no means a comprehensive survey, but the selection of paradigmatic examples allows us to describe and contextualize the models according to their relevant characteristics.

Online access and display of images

Online access and display of images on museum websites represents one of the most widespread and straightforward applications of digitized collections. While, originally museum websites simply duplicated familiar museum products and information, the growing adoption of new technologies has given rise to complete cyber experiences of collections for visitors and art lovers in virtual museum environments or online exhibitions (Liew, 2005). In particular, online access to digital collections may be seen as an innovation in audience reach because in many cases it enhances accessibility to authoritative and trusted content and its related information by complementing the real visitors' experience to physical collections

(Marty, 2007; MTM London 2010). This system may even increase the quality of users' experience by providing a deeper inspection of artworks' details through ultra-high resolution images, or it could expand the "scope" of the visit, allowing users to gain a (virtual) access to the so-called "museum stocks" (Tsichritzisand Gibbs, 1991).

Further, while digital images of artworks have been traditionally displayed on distinct museum websites, this model is also supposed to generate new values as it is increasingly oriented towards aggregation in dedicated platforms of online digital content to reduce users' search costs and improve their virtual experience. With this perspective, the publicly funded initiative Europeana or the commercial Google Art Project represent pioneering experiments to aggregate and link digital images of selected artworks from museums' digital collections in Europe and worldwide.

However, as the online access to digital images on museum websites is generally free, a museum only indirectly appropriate the benefits of the investment of digitization through such a model, especially by promoting the museum collection and augmenting its visibility so to generate revenues from the increased number of visitors, public funding and donations.

At the same time, free online access does not imply a relaxed control over the use and reproduction of digital images displayed. As noted by Eschenfelder and Agnew (2010), museums rely on several technological protection measures, such as visible watermarks, disabling copy and save features on web browsers or (arguably the most effective solution) simply offering low resolution files and thumbnails.

Proprietary Image-licensing

This model is the most traditional and established system to provide access to and use of authoritative and trusted content by museums. For instance, proprietary image-licensing

models have been developed around the principles of conventional print publishing, based on the market of images by the specific segment of commercial and academic publishers.

As a result, the control over the access and use of the digital collections is performed through legal mechanisms and economic barriers.

As the creators and possessors of art images, museums are typically the entities in the position of developing the license agreements and determining what restrictions to place on the use of the images they make available. In most instances, other than where the interpretation of the law has provided otherwise, museums have also maintained photographic copyrights on the images of their artworks, even where the artworks were themselves in the public domain.

Such a system is the only one mainly based on the direct appropriation through pricing schemes of the economic value of the information goods produced. Yet, museums adopt some standard differential pricing strategy for the right to use an image depending on the usage, media, quality and size of digital images, licensing conditions, print run and audience reach. Reproductions for commercial applications are generally charged more than reproductions for educational use and academic publishing, whose price is in some cases zero, due to fee-free images policies for scholarly publishing, such as for the Metropolitan Museum, the British Museum and Tate Gallery (Bray 2009). Regardless the fee charged, license agreements tend to make the process of obtaining and using art images more complicated, time consuming, and costly for permission seekers. Further, transaction costs may be also relevant for users due to the lack of a standard model across museums for the licensing of the images. For example, according to Tanner (2004) the turnaround time for delivering images after payment is in average 2 weeks (with a range of response from less than 24 hours to 6-8 weeks).

In this context, the main enhanced value triggered by digital technologies in such a traditional model has been to offer new opportunities to reduce transaction costs afflicting commercial and scholarly publishers in the search and request for permission to reproduce proprietary authoritative content owned by museums. Also in this case, reduction in transaction costs has been achieved through the aggregation of digital collections on dedicated and specialized platforms for the delivery of digital art images. As noted by Tanner (2004), 30% of the US museums analyzed in his study use either completely or partially commercial specialized photographic agencies to manage their external rights and licensing. Crucially, a handful of photographic agencies, including Artres, Scala Archives, Corbis, Getty Images and the French Reunion de Musee Nationaux (RMN), have cleared the rights for hundreds of millions of art images coming from several prominent museums worldwide (Besser 1997). A similar aggregation trend is occurring also for scholarly and education image licensing. In this case, the Art Museum Image Consortium (AMICO) from 1997 to 2004 and, at present, Artstor are organizations that use licensing instruments and contractual arrangements with their museum partners to gather images of varied but controlled resolution so that they could be offered in the form of a digital library to academic and educational institutional subscribers (Pantalony 2007).

Open image-Licensing

Although digital technologies have contributed to a reduction in transaction costs for proprietary image licensing, such a traditional model based on exclusive control of digital art images is not likely to match new patterns of use and distribution channels occurring on the web. For instance, the dissemination channels in the Web 2.0, such as social networks and the blogosphere, increasingly require a faster and broader access to digital content and

especially a more rapid and efficient system to manage their reuse without seeking every time permission to the right-holder museums. As noted by Benkler (2006), such a demand is essential to support the commons-based peer production systems of knowledge and cultural content in a networked environment.

As a result, new standard copyright licensing models, such as Creative Commons Licenses, have been adopted by some cultural institutions to allow users to use, reuse and redistribute content from their digital collections in an open access framework, subject only to the requirement to attribute and share-alike (Hatcher 2007). The innovation represented by these licenses relative to the traditional model based on the background copyright system is that they make it trivial for people and cultural organizations to give others permission to use their content.

Two initiatives are particularly representative of this model, that is "The Commons" project and the partnership between the Bundesarchiv and the Wikimedia Foundation (Dierickx and Tsolis 2010). The former is a project developed to add publicly-held photography collections of cultural institutions to the open content online platform Flickr under a Creative Commons License to allow viewers to add context to the images by tagging and describing them. The latter refers to a cooperation agreement through which a German public archive released in 2008 some 100.000 images under an open content license to be distributed from Wikipedia, the online platform managed by the Wikimedia Foundation.

To enhance dissemination through the web channel, the images that are provided by the Bundesarchiv are licensed subject only to the requirement to attribute and share-alike. The files released are of slightly reduced resolution (800px on the larger side) that allows the cultural institutions to preserve traditional sources of income from the traditional licensing of images. At the same time, thanks to the integration of images into the Wikipedia articles, the

number of visits to the Bundesarchiv website has steadily increased (Dierickx and Tsolis 2010).

As it clear from the above examples, the main values enhanced by open licensing models not only refer to the reduction in transaction costs for the access and reuse of digital art images of museum collections, but also to the increased visibility of museum collections and to the new knowledge and information generated on art images by commons based peer production systems. Further, being an open access model that favors reuse of art images, museums relinquish a great part of control over the content distributed according to this system. The legal and technical mechanisms, which in the previous models are used to maintain exclusive control over the digital collections, are here used to ease the dissemination of authoritative and trusted content. At the same time, there is no economic barrier to the access and use as digital copies of artworks distributed under such model tend to be fee-free.

User-Generated Art Images

User-generated art images initiatives share with the open licensing model the same approach, objectives and scope as for the access and reuse of museum digital collections. However, they may be considered as a separate organization model because, instead of cultural institutions, users are responsible of the production and dissemination of digital art images under open licensing schemes. As a result, cultural institutions do not own the digital content derived by their physical collections.

As in open licensing experiences, the main initiatives have been based on sharing digital content through open content online platforms such as Flickr and Wikimedia Commons. For example, the “Wiki loves art” project allowed visitors of museums in United States and the Netherlands to take pictures of objects in public domain displayed in their collections and then to upload them to Flickr and license under Creative Commons License subject to the

attribute and share-alike requirements (Dierickx and Tsolis 2010). Similarly, the Smarthistory project has developed a free, multi-media art history web-book publishing images and videos directly produced by contributors from public domain artworks in museum collections (Bakshi and Throsby 2010).

The four depicted models suggest that the transition to digitization is providing a wide range of options for museums in managing their digital collections. Table 1 summarizes the main characteristics of the four models, namely the owner of the digital collection, the customer target, the values enhanced, the appropriation strategies of the economic return generated by those values and the type and quality of control over access and reuse of digital images. The customer target and the values enhanced address how the new business or organization models match old and new users' demand in the digital environment and what are the main benefits provided by cultural organizations to users under such settings.

The type of control defines the instruments available to manage the access and use of the digital collections by the museums. Within this category, the legal dimension refers to strategies based on the legal protection of digital collections as intellectual property assets (i.e. copyright and related rights or contractual provisions). Technical instruments comprises technological protection measures which are generally effective in limiting unauthorized reproduction and copying of digital content even in the absence of effective and enforceable legal instruments, such as copyright protection (Landes and Posner 2003). The economic control takes into account whether within a business model it is used a pricing strategy to regulate the access and use of digital collections.

Finally, appropriation strategies point out whether museums appropriate directly or indirectly the benefits to users deriving from the access and dissemination of digital art images.

	Owner of the digital images	Customers Target	Enhanced Values	Value Appropriation strategy by museums	Type of control *			Examples
					Legal	**Technical**	**Economic**	
Online Access and display	Museum	Visitors and Scholars	Accessibility; Quality of images; Authoritative and trusted content	**Indirect** *Visibility of Collection*	+	++	-	Virtual Museums; Online Exhibitions; Google Art Project; Europeana
Proprietary Licensing	Museum	Traditional Academic and Commercial Publishers	TCs Reduction; Quality of images; Authoritative and trusted content	**Direct** *Revenues*	++	-	+	Commercial Stock photo Agencies; AMICO, Artstor
Open Licensing	Museum	Web users	TCs Reduction; Users-Generated Knowledge; Authoritative and trusted content	**Indirect** *Visibility of Collection*	+	-	-	"The Commons" Project Bundesarchive - Wikimedia
User-generated art images	Web users	Web users	Users-Generated Knowledge;	**Indirect**	-	-	-	SmartHistory; "Wiki Loves Art" Initiative

Table 1 – Models of access and use of digital collections

- The signs + and ++ indicate the extent a control mechanism is used in the model; the sign - indicates that the control mechanism is not relevant or not applied in the model.

As shown in Table 1, each model tends to address different set of values and to satisfy specific customer targets. The main enhanced values by digital technologies are concerning the reduction of transaction costs for the licensing of art images (both in proprietary and open licensing approach), innovation in audience reach and in distribution channels for authoritative content. At the same time, models based on open-licensing and user-generated content favor a participatory and collective creation of knowledge and information on museums' collections. Crucially, the four models differ according to the type of control maintained by the cultural institutions over their collections and to the appropriation strategies through which they capture the economic value generated by the production and dissemination of digital content related to the artworks. On one hand, online access and proprietary licensing models are mainly based on exclusive control over art images for both commercial and non commercial uses. On the other hand, open licensing and user-generated art images models tend to relinquish control to favor access and reuse of cultural content.

4. Challenges for museums in the digital era

The tension between maintaining control and opening up access and reuse of digital collections seems one of the main field of conflict between elders and contemporaries in museums' management and business of digital collections. However, as so far there is not a clear consensus on how museums should respond to the new technological setting and what kind of strategies may provide in the long term higher benefits to cultural organizations and to their audiences, the economic analysis of museum management and the evidence from

current initiatives may at least shed light on the main challenges museums are facing in the management of their digital cultural works.

For instance, museums traditionally face a trade-off between enhancing access to their collections and maintaining financial sustainability (Feldstein 1991; Frey and Meier 2006). As noted by Darnell (1998), in the analog environment there has been a limited number of levers to balance such a trade-off, namely and most importantly the admission price. In this case, since museums are often recognized to face an inelastic demand curve for their collections, an increasing pricing strategy oriented towards raising revenues could lead to a reduction in the number of visitors. As a result, the only way to achieve a balance between the outreach and financial sustainability target could go through exogenous interventions shifting the demand curve, e.g. through advertising or improving the quality of visitors' experience.

Arguably, the management of digital cultural collections may represent an additional lever available to museums to reach both the outreach and sustainability targets. This is particularly true if one considers there is a low substitution or even a complementary effect between virtual and physical visits.

The “digital lever” could actually be used in various different ways to address the outreach/sustainability trade-off. It can be adopted i) to monetize digital collections in order to directly increase revenues, ii) to indirectly raise revenues by increasing the visibility of the collection through partnerships with third parties or crowd-sourcing projects and iii) to redefine the outreach target, including new indicators to take into account the demand for museums' collections in the digital environment. Below, we discuss these three options in more detail.

4.1 Assessing the real commercial value and profitability of digital collections

As museums enter the digital environment as providers of authoritative content, one of the main expectations concerns the profitability of their digital collections and in particular the revenue potential from the commercial exploitation of rights over digital art images. While this is one of the reasons behind developing strategies based on exclusive control, in most of the cases has proved so far to be a missed expectation.

For instance, as noted by Tanner (2004) in his survey on a sample of American museums, 80% of museums investigated process far less than 1,000 image transactions per year and most of these are for non-profit and educational use. Commercial transactions are responsible for the majority of revenues from image licensing, but only 28% of the sample had yearly revenues of more than 100.000 US$ for both image and rights activities. Further, it is interesting to notice that only a handful of objects in cultural collections are driving revenues as most of the museums report that they have a top 10 list of images that attract the most attention. Considering the total budget of museums and the costs to administer the service there is no likely significant surplus or profits against their expenditure and the revenue raised appears to be irrelevant as an indicator of potential profitability of digital collections. Crucially, as almost no cultural institution directly recoups cost from digital image transactions, the main driving factors for the digitization of cultural collections refers to the extension of their public mission in the digital sphere and to the direct benefits accrued to internal museum departments, which are the major users of the digital images.

From a strict economic viewpoint, once the costs necessary to generate, collect and maintain the digital collection are incurred because such an investment benefits the internal operations of a museum, the price for licensing digital copies of artworks might be set at the marginal

cost of reproduction and distribution, which is generally close to zero for information goods in digital format.

As a result, each museum should therefore reconsider its image licensing models in order to find out a proper balance between extracting economic value from the commercial exploitation of its digital collection and increasing the access and so its public mission. This seems particularly relevant for images of artworks in public domain (Hamma 2005)

4.2 Maintaining leadership as providers of authoritative content

Although the introduction of the Internet has not yet materialized great revenue opportunities for museums in licensing their digital images to various commercial and educational markets, a greater challenge facing museums in defining the access and re-use models of digital reproductions refers to their role as providers of valued intangible goods, that is integrity, authority and contextualization of knowledge and information related to physical collections (Pantalony 2007).

As noted by Eschenfelder and Caswell (2010), adopting strategies that increase access and reuse of collections could engage amateur experts to assist with descriptions and to add context to artworks, thereby increasing the value of collections and public commitment to works. Conversely, users' active contribution to the generation of authoritative content raises substantial concerns for the unauthorized use of images or the production of inaccurate content, which potentially may negatively affect the brand value of a museum. As a result, depending on the magnitude of the two opposite effects, maintaining control over the access and reuse of their digital content may either increase or decrease the value of their

collections. Differentiating between different holdings of the collections may be a proper strategy to enhance the value of less known and niche cultural objects while controlling the access and use to most popular works.

Furthermore, the partnerships and collaborative agreements with technology-leading information providers, such as Google and photographic stock agencies, at first glance, may provide new opportunities to increase the value of digital collections and the role of museums as providers of authoritative content through innovative web distribution channels. These new players of the information economy have usually the financial resources and technology to provide enhanced services to museums for the digitization and online dissemination of their collections. Further, if not in a position of strength, a museum may want to partner so as to strengthen its position as being authoritative or its offering in terms of product potential.

Actually, these partnerships have favored greater access to collections or a more efficient delivery of digital images.

However, similarly to the intellectual property concerns raised by publishers in the field of access and use of electronic books (Samuelson 2010), these partnerships may involve serious drawbacks in the long term for museums as to their leading role of stewards of cultural collections in the cyberspace. Depending on how the licensing agreements are framed, the risk is that the new technology-leading information providers would obtain monopoly rents on the access to museum digital reproductions. For instance, endemic network effects in digital information markets tend to drive online users' demand for access to content to a limited number of distribution and content aggregation platforms. As a result, digital content providers would acquire a dominant position over original content producers, such as

museums. Further, while museums have to provide access to high-resolution images of their collections, these players are likely to exploit better than established cultural institutions the full potential of this content by developing innovative applications for online uses.

4.3 Developing new metrics for museum accountability

As the transition to digitization has enabled to track and deeply inspect how users access and consume online content, the knowledge about how museum content is utilized is an important asset to the organization for assessing the social impact and success of its activities or the fulfillment of its inherent public mission. Moreover, institutions are under pressure to show that cultural initiative in general and digital initiatives in particular have a tangible impact, and access and use data and similar metrics represent a measurable form of cultural benefit (Eschenfelder and Caswell 2010).

Arguably, the proprietary image licensing and online display models have been usually supported by the use of metrics on access and revenue generated, such as online visitors image sale statistics, which do not greatly differ from the traditional measures concerning the number of visitors used by museums in the analogue setting.

Conversely, although open access models seem to reduce the capacity of a cultural institution to monitor how digital reproductions are reused in the cyberspace some pioneering initiatives suggest that through digital image metadata it is possible to track how audiences are integrating and connecting knowledge and information regarding the museum artworks with Web 2.0 tools (Bray 2009). For example, the images provided under an open licensing scheme by the Brooklyn Museum to the Wikimedia Foundation are monitored according to

the new tags and information added or modified and to the number and type of Wikipedia articles that are currently using one image of the collection. To date, the re-use on Wikipedia represents one of the most easily traceable forms of creation of derivative cultural works and/or of creations of new context and links for collection images. This is the case thanks to the systematic use of the aforementioned tags and metadata, however the ongoing developments in the domain of the Semantic Web (see projects such as DBpedia.org or Freebase.com) suggest that similar metrics will be richer and more precise in the foreseeable future. Moreover, organizations developing open licensing tools, such as Creative Commons, also offer to the public rich systems of metadata which can already be used to monitor the re-use of licensed content (Abelson et al. 2008).

As a result, open access (and re-use) models have the potential to trigger the development of new tracking methodologies for a better assessment of the reuse patterns of museum digital collections in terms of knowledge and information creation about museum works. This, in turn, may attract new resources for the museum in general and for open access projects in particular, possibly representing a key element in the sustainability strategy related to digitization processes.

5. Conclusion

The article has explored what are the main challenges and strategies for museums in managing the access and use of their digital collections. The transition to digitization and to a digital network environment is likely to transform the way knowledge and content related to physical collections is produced and managed both by museums and users.

With this perspective, the paper has provided an analytical framework to investigate the economic implications of the digitization of museums' cultural material and to identify what are the main organizational and business models developed by cultural institutions to cope with such technological change. As in other digital domains, the evidence from paradigmatic museums' and users' initiatives suggests that the main field of conflict between elders and contemporaries in this context lies in the choice between maintaining control or opening up access and reuse of the digitized cultural content. Crucially, to better understand how to solve such a tension, more in-depth studies and empirical evidence is required. In particular, future research paths should address how and to what extent museums can capitalize on the commercial value of digitized collections, on their role of leading providers of authoritative content and on the development of new metrics to account for their public mission in the digital environment.

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