

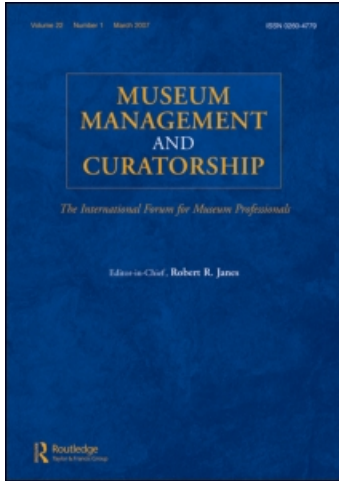
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DIGITAL HERITAGE

The presence of Web 2.0 tools on museum websites: a comparative study between England, France, Spain, Italy, and the USA

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In recent years, the Internet has become a place for participation, collaboration, and social exchange thanks to Web 2.0 tools. Museum websites are starting to incorporate these tools to involve audiences in ways that reach beyond the physical museum visit. This paper presents research exploring the extent to which museums in five countries (Italy, France, Spain, England, and the USA) have adopted Web 2.0 tools on their websites. Two hundred and forty museum websites belonging to four categories (arts, natural sciences, social sciences, and specialized) were analyzed, with results showing a low overall presence of Web 2.0 tools on museum websites, as well as significant differences in the use of Web 2.0 tools among countries and categories. The paper concludes with a discussion of the diversity of approaches in the use of Web 2.0 tools on museum websites.

Keywords: Web 2.0; Museum 2.0; museum websites; participation; education; visitor experience; web tools; digital heritage; social networking

Introduction

The relationship between museums and technology is not new. For more than 50 years, museums have been using different types of technology to organize, catalog, and communicate facts about their collections (Parry, Poole, and Pratti 2008; Trant 2006). During the 1990s, a growing awareness of the museums' cultural, social, communicational, and educational roles in society, along with increased public Internet access, has made museums increasingly interested in digitizing their collections, artworks, and documents, with the aim of making them more publicly accessible (Crenn and Vidal 2007). Many museums have invested in facilities allowing users to utilize the multimedia characteristics of the World Wide Web (the Web) to magnify art pieces and delve into technical and historical details. By 2004, 88% of museums had websites (Institute of Museum and Library Services 2006).

General information on opening hours, ticket prices, calendars of events, maps, and directions is usually found on museum websites. Although this kind of information is very valuable for the visitor, the ongoing development of web tools belonging to a new generation known as Web 2.0 has opened new possibilities for museums to communicate and interact with their public (Antinucci 2007; Dawson 2008). As cultural mediators, museums are called on to be inclusive and sensitive to visitors' needs, in order to make heritage material available to a vast community and

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to bridge the gap between them (ICOM 2006). Using Web 2.0 tools, museums have the potential to create new learning opportunities based on their users' and visitors' involvement and active participation – transforming their museum experience. In addition to acquiring, preserving, and safeguarding tangible and intangible heritage, museums are called upon to play an educational role in their community interactions (ICOM 2006). Using new tools on their websites, and taking advantage of their potential, means not only keeping abreast of technological developments, but also providing a unique way of fulfilling the museum's duty to promote and make new cultural and learning opportunities accessible.

With the growing popularity of Web 2.0, there are an increasing number of research projects and studies aimed at describing and analyzing the specific ways in which Web 2.0 tools may be used by museums (Bernstein 2008; Gates 2007; Spadaccini 2006; Springer and White 2007; von Appen et al. 2009). However (to our knowledge), there is currently no research being undertaken specifically to explore the extent to which Web 2.0 tools are being used by museums on their websites. The aim of this research was to identify technological tools offered on museum websites with a particular focus on those defined as Web 2.0 tools. We adopted a user perspective approach to analyze not *what* museums declare they use in their websites, but *how* these tools are presented to the user. To guide this exploratory study, we posed two research questions:

- (1) Which Web 2.0 tools are being adopted by museums on their websites?
- (2) Are there any differences between countries and museum types?

This article provides a comparison of technological adoption in five countries (France, England, Italy, Spain, and the USA) and in four different categories (museums of art, natural sciences, human sciences, and specialized).

What is Web 2.0?

Although the expression 'Web 2.0' suggests a new software version for the Internet, it actually refers to changes in how people use the Web and conceive of their online experience. From being simple, passive web navigators and readers, users have become active and conscious authors. We have arrived at the phase which marks the path from interactivity to *intercreativity* (Berners-Lee 1999). Today, any user has the possibility to publish content on the web in a simple and intuitive way, whether text or multimedia material. New, user-friendly interfaces can be used even by those who are not familiar with programming languages. Moreover, some of these tools foster the co-construction of contents in a collaborative way. This phenomenon of active participation, involvement, personalization, collaboration, and content sharing among an increasingly broader population is known as Web 2.0 (O'Reilly 2005).

In creating the areas for personal expression, Web 2.0 has enormous potential to activate the main principles of socio-constructivist learning theory. Thanks to tools that support participation, sharing, and collective knowledge construction, the user is encouraged to actively construct personal meaning, in a situated context, which is closer to his or her own experience. In the museum context, the possibility of having a voice in relation to cultural material allows the visitor/user to make a cognitive and affective connection, thus facilitating a more significant learning experience (Fisher

and Twiss-Garrity 2007). The museum and its collections may become the aggregating center for voluntary processes based on discussion, exchange, collaboration, and collective knowledge building, which is where the heart of the educational experience resides (Crenn and Vidal 2007).

Web 2.0 also provides more opportunities to learn. Web 2.0 websites tend to be more 'sticky' even if hard data are difficult to get. Some statistics show that in these websites visitors stay longer and visit more often, and consequently learning opportunities are longer and repeated in time (Samis 2008; Spadaccini 2006). From the Web 2.0 perspective, the museum's pedagogical duty cannot be accomplished by simply offering information about collections, but needs to explore new avenues toward knowledge and enhance elaboration, interpretation, and contrasting processes as important learning events (Crenn and Vidal 2007).

Examples of Web 2.0 tools on museum websites

Tags, blogs, wikis, forums, podcasts, mashups, Facebook, YouTube, iGoogle, and Flickr – the list of tools and sites associated with Web 2.0 becomes longer everyday. These tools are examples of the multiple ways in which users can create, collaborate, and communicate, and some have a special relevance for objectives in a museum context (MacArthur 2007). In addition, their design and use often reflect the pedagogical perspectives of curators, educators, or web designers (Hawkey 2004).

Web 2.0 tools are already available and there are a growing number of museums that are incorporating them into their websites. Outstanding examples of museums using Web 2.0 instruments can be found navigating on the Internet. In April 2008, the San Francisco Museum of Modern Art¹ (SFMOMA, CA, USA) began the Open Space blog. A blog is an online tool that allows users unskilled in programming to publish text and images. Other users may make comments, sometimes generating a sort of conversation. The purpose of the SFMOMA was to invite the community to participate, discuss, and write opinions, comments, and critiques regarding the museum, its events and any other museum-related topic. The SFMOMA blog is very dynamic: since its creation, museums contributors post almost everyday, and visitors are active in making comments on these entries. Subscribers learn about blog updates through RSS (Really Simple Syndication) feeds, a tool that allows users to receive information related to their personal interests. Specific buttons allow bookmarking and exporting of blog entries to external sites for sharing and social networks, such as Facebook, Del.ici.ous, MySpace, and Flickr.

The Newark Museum² (NJ, USA) offers a wiki associated with specific exhibitions. Wikis are online writing spaces that allow multiple users to collaboratively author a text. Users may modify and even erase what other users have already written, adding, and/or correcting the information that may be eventually wrong. In this way, the museum promotes collaboration with the community, giving it a space to contribute to the generation and understanding of the museum contents.

The Museo de la Alhambra³ (Spain) offers a series of podcasts featuring curator-led tours which may be downloaded and then listened to with a portable MP3 player while visiting the museum. The user can choose which podcasts to download, thus allowing a combination of online and onsite resources for a personalization of the museum experience. Subscribing to the museum's RSS feed notifies the user about new podcasts being posted.

Research methods

This research study analyzed 240 museum websites situated in France, England, Italy, Spain, and the USA. The choice of country was determined by the researchers' language skills (English, French, Spanish, and Italian), as familiarity with the language used on the website is a fundamental part of website analysis. All selected museums have a physical venue and at least one permanent collection. Museums existing only as a virtual presence were excluded from the analysis.

Participant websites

Since the purpose of this study was to make a comparison among countries and museum types, the number of websites needed for the analysis was calculated to ensure sufficient cases to detect significant differences. With power = 0.85, $\alpha = 0.05$, and a desired size effect = 0.30 used to detect a difference among countries and categories, 215 websites were estimated to be essential. We decided to use 240 in order to balance the number of websites per country and category. The final power of the research design was 0.9.

Two cross-parameters were followed for the selection of the participant websites: physical location and museum category. As to location, museums were chosen following a socio-demographic criterion. First, museums located in the country's capital city were selected; then, those of the first more populated city, based on the most recent population census, followed by those of the second most populated city, and so on. As to museum categories, we selected four: *arts and decorative arts*; *natural sciences* (including botanical gardens and planetariums); *human sciences* (e.g. social, historical, and technological sciences); and *specialized* (devoted to very specific subjects, such as shoes, chocolate, soccer teams, etc.). With these criteria in mind, 12 museum websites per country in each category were selected, totaling 48 websites for each country.

Using the Google search engine, museums were chosen mainly from the online lists of each city's museums. We considered that visibility on one of the most widely used search engines was an indicator to keep in mind when selecting the museums. When a group of museums are managed by a single governmental or private institution, their websites sometimes share the same structure, graphics, and technological resources. In those cases, only one museum in the group was chosen for the study. Museums belonging to universities or similar institutions, which do not have separate web domains, were considered on condition that the web pages had their own structure and were independent of the parent institution.

Research instrument

A checklist was drawn up for research purposes which consisted of 24 items with a dichotomous structure indicating the presence/absence of a specific technology feature or tool. Although not all of them qualified as Web 2.0 tools, certain technologies were included in the analysis in order to have a broader overview of the technological approach adopted by each museum website. We considered all technologies and instruments that allow social exchange, collective knowledge construction, sharing, and active participation to be Web 2.0 tools. Resources

designed to be used in Web 2.0 external applications (such as mashups and feed readers) were also included in this category.

The checklist addressed the presence and use of the following technologies and tools:

Non-Web 2.0 tools and technologies:

- (1) Text and images to present information, plan a visit to the museum or go deeper into a specific subject.
- (2) Multimedia (audio/videos/podcasts/animations) to present information, plan a visit to the museum or go deeper into a specific subject.
- (3) Detailed virtual access to collections (for example, pictures that may be explored in detail with a virtual magnifying glass, books that may be leafed through, etc.).
- (4) Camera type formats allowing a virtual visit to the rooms, halls, and/or gardens of the museum.
- (5) Tools to create a personal gallery hosted by the museum website (e.g. 'My gallery' or 'My favorites'), requiring a personal login and password to access the pieces chosen and the personal descriptions written by the user.
- (6) Online guestbook.
- (7) Single-player games involving a collection or exhibit.
- (8) Tools for a single user to create simulations or conduct experiment.
- (9) Tools for a single user to promote creativity (e.g. drawings, reconstructions of historical sites, or events).

Web 2.0 tools and technologies:

- (10) RSS feed to keep users and visitors updated about the museum's activities.
- (11) Mashup modules to include in user's personal pages (e.g. iGoogle).
- (12) Free forums where users are allowed to freely post-comments.
- (13) Forums requiring the museum moderator's approval before posting.
- (14) Blogs (this item also documented how updated blog posts were).
- (15) Chat-room with museum curators, guest artists, or professionals.
- (16) Tools to upload material to the museum website (texts, images, podcasts, and videos).
- (17) Multiplayer games.
- (18) Wikis.
- (19) Commenting tools, in which comments are accessible to other users (Amazon.com style).
- (20) Tagging tools accessible from the museum website, in which users can see their tags as well as those made by other users.
- (21) Tools to link collections and/or exhibits to external sites.
- (22) Tools that allow sharing through social sharing sites (e.g. YouTube, Flickr).
- (23) Tools for spontaneous creation, simulation, or experimentation in collaboration with other users.

- (24) Buttons to add and link museum resources to the users' personal archives in sharing sites (e.g. Yahooweb, Facebook).

An early version of the checklist was pre-tested by two researchers who analyzed five museum websites. These museums belonged to countries and cities that were not included in the main research project. Both researchers analyzed the same museums and then presented their results. This trial allowed us to better define some items and to adjust the items' scoring criteria. The final instrument's reliability was tested using Cronbach's α , which measures the internal consistency of the scale by analyzing the correlation between each of the items that compose it. Scores vary between zero and one, and the higher the alpha, the higher the scale's internal consistency. Conventionally, an alpha of 0.60 is considered acceptable, 0.70 adequate, and 0.80 good. For the case in hand, results show that the checklist has an internal consistency of 0.76.

In addition to the checklist items, there was a special section based on two dimensions designed to evaluate the quality of website navigation: *simple/complex* considered the presence of two or more link levels and *easy/confusing* evaluated the intuitiveness or difficulty in navigating the website. These dimensions gave rise to four navigation categories: *complex/easy*, *complex/confusing*, *simple/easy*, and *simple/confusing*. We noted that it was more difficult to analyze websites that had a *complex/confusing* navigation, for there was a risk of not noticing links that were positioned in places that were hard to see. For this reason, websites labeled this way were analyzed twice.

Data collection and analysis

The present study was part of the research activities on the pedagogical use of Web 2.0 tools for learning, carried out by the Laboratory of Audiovisual Technologies for Learning at Roma Tre University. Previous experiences and results have been published elsewhere by participating investigators (Fiocchetta, Maragliano, and Pireddu 2007; Maragliano et al. 2007). Two researchers participated in the data collection phase. Websites selected for the study were analyzed by a single researcher, except when there were doubts as to their navigation structure. Data collection was done between March and May 2008.

Two types of analysis were carried out. Initially, we compared the variables' frequencies calculated for each country and each museum type, and we tested the independence hypothesis by using X^2 statistic. A probability level p less than 0.05 was considered statistically significant. The collected data were analyzed using SPSS 16.0. A correspondence analysis (Greenacre 1984) was performed afterwards to graphically identify the association among variables. This analytical procedure is used for identifying and graphically visualizing the association among tools, countries, and museum types.

Findings

The global percentage of the different technological tools surveyed is shown in Figure 1. Results by country and by museum type are presented in Tables 1 and 2. Significant differences are flagged with * or ** symbols.

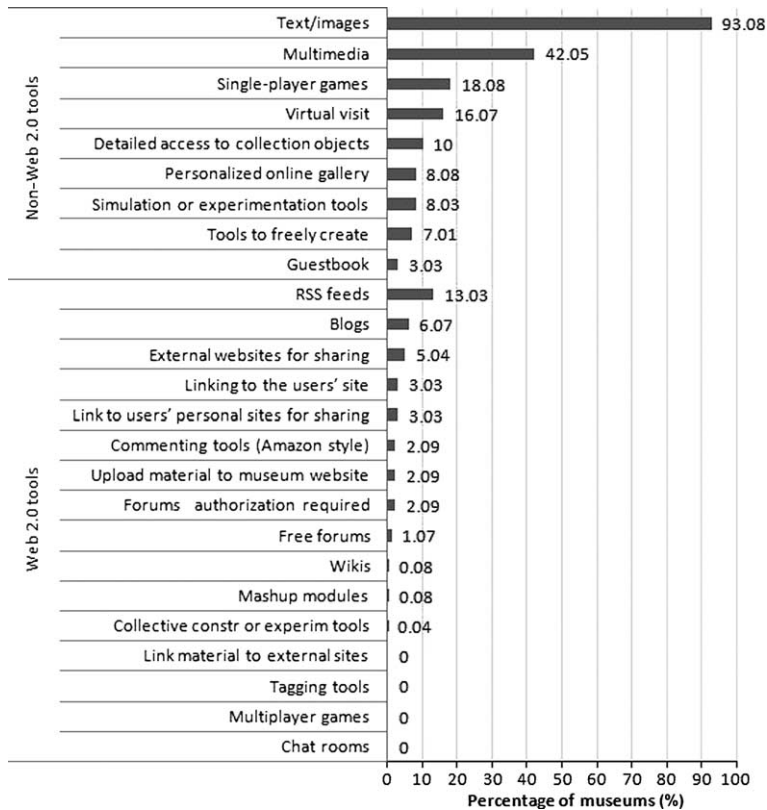


Figure 1. Global presence of Web 2.0 tools in museum websites.

Non-Web 2.0 tools and technologies

Most museums (93.8%) offer the basic information needed to plan a visit to the museum and/or to look up specific subjects relating to the collections. However, more than half use static text and images rather than a multimedia format (42.5%). In this choice, a statistically significant difference emerges between countries ($X^2_{(4, 240)} = 26.36, p = 0.01$) and between types of museums ($X^2_{(3, 240)} = 8.52, p = 0.05$). Only 10% of museums offer means for a detailed access to collections pieces – mostly museums in the USA ($X^2_{(4, 240)} = 15.46, p < 0.01$) and art museums ($X^2_{(3, 240)} = 16.66, p < 0.01$). With negligible statistical differences between countries and categories, 16.7% of museum websites provide a virtual visit to the museum.

About 8% of the museum websites offered the possibility of creating a personal gallery using the museum's collection pieces. Again, these sites are mainly found in English (14.6%), American websites (16.7%), and in art museums (21.7%). The difference is statistically significant compared to museums websites in other countries ($X^2_{(4, 240)} = 10.12, p < 0.05$) and with other museum categories ($X^2_{(3, 240)} = 17.27, p < 0.01$). Guestbooks, used by 3.3% of museums, are more common in specialized museums.

Approximately, 18% of all the museum websites analyzed have single-player games. The majority of them are in English museums (35.4%), followed by American

Table 1. Technological tools found in museum websites – difference between countries.

		IT	FR	ES	ENG	USA
Non-Web 2.0 tools	Text/images to plan a visit	87.5	97.9	91.7	100.0	91.7
	Information using multimedia format*	25.0	39.6	25.0	62.5	60.4
	Detailed access to collection objects*	8.3	6.3	4.2	6.3	25.0
	Virtual visit	12.5	14.6	22.9	18.8	14.6
	Personalized online gallery*	4.2	6.3	2.1	14.6	16.7
	Guestbook	2.1	4.2	2.1	4.2	4.2
	Single-player games*	4.2	14.6	12.5	35.4	27.1
	Simulation or experimentation tools	6.3	4.2	4.2	14.6	12.5
	Tools for free creation	2.1	2.1	6.3	12.5	12.5
Web 2.0 tools	RSS feed*	2.1	8.3	6.3	27.1	22.9
	Mash-up modules	0.0	0.0	0.0	0.0	4.2
	Free forums	2.1	2.1	0.0	4.2	0.0
	Forum authorization required for posting	0.0	2.1	4.2	4.2	4.2
	Blog*	0.0	4.2	2.1	10.4	16.7
	Chat room	0.0	0.0	0.0	0.0	0.0
	Tools for uploading	0.0	0.0	2.1	8.3	4.2
	Multiplayer game	0.0	0.0	0.0	0.0	0.0
	Wiki	0.0	0.0	2.1	2.1	0.0
	Commenting tools (Amazon style)	2.1	2.1	0.0	8.3	2.1
	Tagging tools	0.0	0.0	0.0	0.0	0.0
	Link material to external sites	0.0	0.0	0.0	0.0	0.0
	External websites for sharing (e.g. Flickr, YouTube)	2.1	4.2	2.1	8.3	10.4
	Link to users' personal sites for sharing (e.g. Facebook)	0.0	0.0	2.1	6.3	8.3
	Space for collective construction or experimentation	0.0	0.0	0.0	0.0	2.1
Links to add the museum website to the users' site	0.0	0.0	2.1	6.3	8.3	

* $p < 0.01$.

museums (27.1%), making a significant difference compared with the other countries ($X^2_{(4, 240)} = 19.41, p < 0.01$). All museum categories use games; one-third of the games are found in art museum websites, while the other categories use them significantly less ($X^2_{(3, 240)} = 9.27, p < 0.05$).

About 8% of museums propose activities to be used individually for simulating and experimenting in their websites (e.g. virtual labs, changing characteristics of collection exhibits). A similar number of websites have tools that allow single users to freely create (e.g. designing and using objects to create new ones). Even if there are no significant differences among countries, American and English websites take the lead. With regard to museum categories, art museums show a clear predominance over the rest of the categories in their use of simulation and experimentation tools ($X^2_{(3, 240)} = 10.90, p < 0.05$), as well as for tools for free creation ($X^2_{(3, 240)} = 21.46, p < 0.001$).

Table 2. Technological tools found in museum websites – difference between museum types.

	Arts	Natural sciences	Human sciences	Specialized	
Non-Web 2.0 tools	Text/images to plan a visit	95.0	91.7	95.0	93.3
	Information using multimedia format*	55.0	38.3	46.7	30.0
	Detailed access to collection objects*	23.3	5.0	8.3	3.3
	Virtual visit	25.0	11.7	18.3	11.7
	Personalized online gallery*	21.7	6.7	3.3	3.3
	Guestbook	5.0	0.0	1.7	6.7
	Single-player games*	31.7	16.7	15.0	11.7
	Simulation or experimentation tools	16.7	8.3	8.3	0.0
	Tools for free creation	20.0	3.3	5.0	0.0
	Web 2.0 tools	RSS feed*	26.7	6.7	15.0
Mash-up modules		3.3	0.0	0.0	0.0
Free forums		1.7	3.3	0.0	1.7
Forum authorization required for posting		6.7	0.0	3.3	1.7
Blog*		16.7	1.7	6.7	1.7
Chat room		0.0	0.0	0.0	0.0
Tools for uploading		6.7	0.0	3.3	1.7
Multiplayer game		0.0	0.0	0.0	0.0
Wiki		0.0	0.0	1.7	1.7
Commenting tools (Amazon style)		3.3	1.7	3.3	3.3
Tagging tools		0.0	0.0	0.0	0.0
Link material to external sites		0.0	0.0	0.0	0.0
External websites for sharing (e.g. Flickr, YouTube)		11.7	5.0	1.7	3.3
Link to users' personal sites for sharing (e.g. Facebook)		6.7	3.3	1.7	1.7
Space for collective construction or experimentation		0.0	0.0	1.7	0.0
Links to add the museum website to the users' site		6.7	3.3	1.7	1.7

* $p < 0.01$.**Web 2.0 tools**

There is a low overall percentage of museums offering tools to personalize information. An RSS feed is the most frequently used tool for this purpose, featuring in a total of 13% of museum websites. It is present in 27.1% of English museum websites and in 22.9% of American websites, which is significantly higher than in other countries ($X^2_{(4, 240)} = 20.04, p < 0.01$). This tool is mostly used by art museums (26.7%) and human sciences museums (15.0%), which makes them statistically different from museum websites belonging to other categories ($X^2_{(3, 240)} = 15.28, p = 0.002$). Among the 240 museum websites analyzed, only two museums were found to provide mashup modules.

Forums are uncommon tools in museum websites, featuring in only 3.5% of the museum websites in the study. Most of them require authorization from the museum staff before posts are published on the website.

Blogs are present in 6.7% of all the museums reviewed. Most blogs are found in websites belonging to museums located in the USA (16.7% of all the museum blogs), followed by England (10.4%), while in the other countries their use is still very uncommon. The difference is statistically significant among countries ($X^2_{(4, 240)} = 18.04$, $p < 0.05$) and among museum categories ($X^2_{(3, 240)} = 14.46$, $p < 0.01$). In art museum blogs, most comments require authorization by the museum staff before being posted. Among those museums presenting one or more blogs, most of them (16 out of 21) were updated, with posts 11 days old or less. No chat rooms were found in the websites analyzed and forums are only used by 3.7% of museums. This study did not find museums implementing multiplayer games or linking museum pieces to other external websites.

Tagging tools, either accessible through the museums' website or suggested to the visitors/users, were not found in the websites analyzed. Three art museums in the USA permitted tagging art pieces from their collection using the Steve Project site; however, there were no links on those museum websites to the Steve project site.

Only two museums have implemented a wiki, one of which received an award for innovation in 2007. Seven museums allow users to upload material to the museum's website and most of them are art museums located in England.

Similarly, the possibility of commenting on collection pieces exists in less than 3% of all museums reviewed. This possibility is independent of the museum category: two websites belong to art museums; two to human sciences museums; two to specialized museums; and one to a natural sciences museum.

A total of 13 museums, corresponding to 5.4% of all museum websites visited, use external sites such as YouTube and Flickr for sharing museum-related materials. Nine of these museums are located in England and the USA (four and five, respectively), and 10 are art museums.

A small number of museums use a 'Share this' button or other similar tool to link the museum website to the users' own spaces on the web such as Yahooweb, MySpace, or Google Bookmarks. Those few who use these tools are mainly art museums situated in England or the USA. In summary, apart from blogs and RSS feeds, there are no significant differences between countries or museum categories in relation to the use of Web 2.0 tools.

Correspondence analysis

Correspondence analysis (Greenacre 1984) was performed on the contingency table Museums \times Items, in order to acquire global comprehension of the use of technological tools in museum websites. This technique provides a graphical representation of relationships between rows (columns) and between rows and columns of a two-way table, making it possible to detect a pattern of association characterizing data.

All items with a total frequency of appearance under 2% in the 240 websites were removed and not considered for the analysis, in order to curtail their influence on the graphical results. Hence, correspondence analysis considered 16 of the 24 items of the checklist. Results concerning the first two factorial dimensions (26% explained

variance) are presented in Figure 2. For interpretative purposes, each country, museum category, and website navigation were also projected on the plane.

Figure 2 shows a polarized association between countries, museum categories, and type of navigation, and the variables characterizing the technology used in museum websites. On one hand, it can be seen that Italian, French, and Spanish museums are mainly characterized by a simple navigation, presenting information to users using text and static images, with little use of technological tools beyond the multimedia format. When other tools are considered, the tendency is to choose instruments that allow a virtual visit to the museum by controlling a video camera or a 360° image, or to include a guestbook in which users may leave messages and comments to the museum curators. The same trend is shown by natural sciences museums, human sciences museums, and specialized museums.

Items characterizing museums that use more complex technology and Web 2.0 tools are situated on the other side of the graph. These instruments tend to be in English or American museum websites, and in art museums. The most common tools used by these museums tend to be RSS feeds, single-player games, and virtual spaces for simulating and/or experimenting in subjects associated with the museums' collections. In addition, the navigation style of these websites tends to be more complex but not necessarily more confusing.

Discussion

The aim of the present study was to identify the technological tools in use on museum websites, with a particular focus on Web 2.0 tools, and to compare the prevalence of these instruments in five different countries (Italy, France, Spain, England, and the USA) and among four museum categories (art, natural sciences, human sciences, and specialized). This study provides a comparative profile of

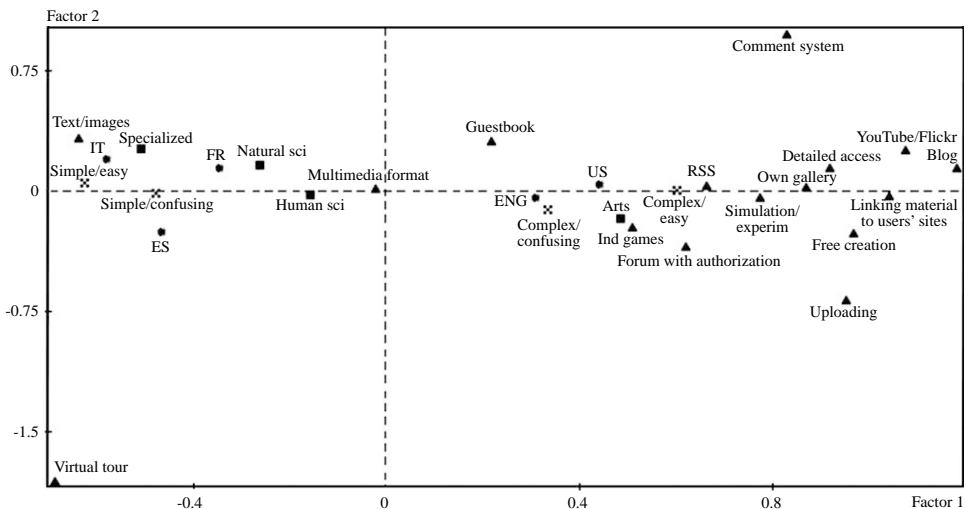


Figure 2. Correspondence analysis – association among technological tools in museum websites.

Downloaded By: [Lopez, Ximena] At: 23:08 21 May 2010

technological implementation, offering valuable evidence of the current practices adopted by museum websites to accomplish their missions.

Literature reviews of museums and their presence on the web highlight the importance of adopting Web 2.0 instruments and social networking tools on museum websites (Durbin 2008; Greenfield 2008; Hawkey 2004). However, results from this study indicate that the use of tools for participation and collaboration on these websites is still very scant, despite their being widely accepted and used in other sectors such as business, the press, and media (McKinsey Quarterly 2007). These findings empirically support previous analyzes (Crenn and Vidal 2007; MacArthur 2007; Trant 2006) and emphasize that there are still many museum websites in various countries, conforming to a fixed information transmission model of knowledge, which are highly structured according to the museum's concepts and ideas and cannot be integrated with non-expert knowledge. As Trant (2006) pointed out, 'Collections are available, but not really accessible' (84).

The research results presented here contrast with reports showing that museums, particularly medium-sized and large institutions, were early adopters of websites and other technologies with the aim of making their collections widely available. While in 2004, 10 years after the Internet became accessible to the public through Netscape Navigator, the majority of museums had a website (Institute of Museum and Library Services 2006), results drawn from this study suggest that the Web 2.0 uptake is not happening to the same degree, given that almost 10 years after the appearance of the first easy-to-use tools for user content construction (such as Blogger in 1999), the availability of Web 2.0 tools in museum websites is still very rare.

The overall low prevalence of Web 2.0 tools in museum websites may reflect the way museums conceive of their roles as educational and cultural institutions (Hawkey 2004; Peacock 2008). Typically recognized as one of the most trusted sources of information, even more than books and television news, museums have been respected not only for providing independent and objective information, but also for their ability to transmit a clear and faithful interpretation to their visitors (MacArthur 2007). The new knowledge construction dynamics mobilized by Web 2.0 could be seen by the museum as a threat to its cultural-educational role, as well as to its historically accorded right to know how to discern beauty from beastly, important from insignificant, and art from the commonplace. From the moment in which any visitor may express and share his own opinion, give a personal meaning to collections, and propose new interpretations to other users, the frontier which made museums the only authority capable of submitting value judgments becomes thinner.

We also found that some museum websites were willing to make Web 2.0 tools available (i.e. blogs), but lacked continuity over time, having left these tools without any further updating. Knowledge in Web 2.0 websites should not be a static, but a dynamic, evolving, and ever-changing process that needs to be followed-up in all its phases, and this involves energy and resources. These activities cannot be left to their own devices; they must be tracked, stimulated, and sometimes even welcomed in order to increase participation and make the user feel he is truly collaborating with the museum. This requires putting into practice well-articulated efforts and actions such as staff training, external technological consulting, and new organizational policies that may not be part of the museum's regular practices (Ellis and Kelly 2007), and which may influence the museum's willingness to adopt these tools. Furthermore, this suggests that, unless Web 2.0 instruments are managed

strategically by the museums' professionals, it is unlikely that these tools will be implemented and used successfully.

This study shows that actively used Web 2.0 tools are generally found in websites belonging to museums located in English-speaking countries, namely England and the USA. This result is consistent with financial reports indicating that major investments in the Web 2.0 industry have been made in the USA and in the UK (Canning 2007). However, if economic factors were the only ones involved in determining the adoption of these tools, French museums would have a similar level of Web 2.0 tools in their websites, a supposition not supported by this study. This suggests that organizational barriers previously described in the literature (Antinucci 2007; Ellis and Kelly 2007; Peacock 2008) may have a powerful influence on the decision as to whether to allow a public voice in the museum. Italian, Spanish, and French museum websites appear to use technologies and tools that do not actively promote user participation. Instead, they foster interaction styles based on the old Internet model, using static text and images to transmit information.

Conclusion

The results presented in this paper stressed the importance of looking at the Web to analyze how new tools are being used and for which purposes. This study has only scratched the surface of the Web 2.0 phenomenon and further research is needed for a deeper comprehension of the impact that Web 2.0 tools have on museum visitors and their role in accomplishing the museum's mission. Future research, for example, could delve into how museum professionals and staff evaluate the potential of Web 2.0 tools to accomplish the museum's mission, in order to acquire a more complete overview of the relationship between museums and Web 2.0. It would also be interesting to examine how online participation and collaborative activities affect actual visits to museums, or how online and onsite activities could be combined to maximize the visitor experience in museums. As museums become more aware of the possibilities offered by Web 2.0 tools, new studies will be needed to determine the adoption rate of these instruments and the innovative practices that best suit the museum's objectives.

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Notes

1. <http://www.sfmoma.org/>
2. <http://www.newarkmuseum.org/>
3. <http://museoalhambra.wordpress.com/>

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