This essay is published in Niels Brügger (ed.), Web 25. Histories from 25 Years of the World Wide Web (New York: Peter Lang, 2017), pp.157-72.

This version is subsequent to peer review but before type-setting and proofing, so don't cite this, cite the version of record, available from https://www.peterlang.com/view/9781433140655/chapter-011.xhtml

The Changing Digital Faces of Science Museums

A diachronic analysis of museum websites

Anwesha Chakraborty & Federico Nanni

1. Introduction

In recent years, web history (Brügger, 2010) has started to receive substantial attention in internet studies and digital humanities, and its theories and methods have been applied to political science research (e.g. Foot et al., 2003; Ben David, 2015) as well as cultural and social history (e.g. Milligan 2015). Inspired by this academic development, this chapter is intended to be a starting point to discuss how prominent scientific institutions develop their websites over a period of time to communicate better with their visitors. More specifically, this work presents the formulation of a methodology for using websites as primary sources to trace and examine activities of scientific institutions through the years. This is achieved in three steps: first, we diachronically analyse snapshots[1] of pages of select museum websites from the Internet Archive, the most important and comprehensive web archive (Howell, 2006). Then, we combine this analysis with interviews of the current website managers and with resources available on the live web.

The choice to study museums was prompted by the fact that these institutions are perceived by the civil society as authoritative custodians of artifacts, culture and heritage. This is true for science and technology museums as well, which have the additional task of communicating specialised (and often less understood) branches of knowledge. In the

[1] Links of analyzed snapshots have been indicated as footnotes.

last twenty years the World Wide Web has become ubiquitous and websites have affirmed themselves as one of the first points of communication with museums (Wilson, 2011). However, from our research it has become apparent that little work has been done so far on using websites as primary resources to trace the history of the representation of scientific institutions on the web. Thus, the goal of our research is to understand how science museum websites have transformed over time and what these changes imply in the larger context of growing functions of websites.

The three case studies we have chosen include some of the most prominent science museums in Europe: the Science Museum, London; the Deutsches Museum, Munich and the Museo Nazionale della Scienza e della Tecnologia (hereafter, Museo della Scienza), Milan. We chose the Museo della Scienza to carry out the first round of interviews because of our spatial proximity to the museum[2]. At this stage, we also felt the need to include a few more representative examples, and thus we selected the Deutsches Museum and the Science Museum, which regularly feature among the most visited science museums in the world[3]. The rationale for selecting a number of cases is to examine a similar set of institutions (in this chapter, museums of history of science). These institutions have increasingly been providing greater number of hands-on activities alongside the traditional displays of artifacts to encourage visitor participation. This is also reflected in how websites have changed through the years.

In this chapter we present a periodisation of the phases of significant structural and functional changes of the websites. The chapter chronicles what the websites have done since they were digitally born; what have been the milestones in terms of their development and the trajectory they are pursuing for better communication and relations with the public. It is important to point out that this work does not intend to offer a comparison of the three museums; rather the idea is to use a set of case studies to demonstrate our methodology, which focuses on the analysis of websites as primary sources for studying the recent history of scientific institutions.

---

[2] One of the authors carried out a period of research at the Museo della Scienza in early 2015.

[3] See for instance http://museumplanner.org/worlds-top-10-science-centers/

2. Importance of museum websites

While there is little attention paid to websites as primary sources in museum studies, they have not been overlooked in discussions on the vast potential of digital domains in improving communication. Morrison (2006) states that a museum these days is not just the building, the collections and the staff, but also the website. Museums can connect with their visitors by providing them with more tools for personalized visits to the institution through their websites (Bowen et al, 1998; Bowen and Filippini-Fantoni, 2004). Marty (2007) argues that websites also boost attendance to the physical museum, and that a museum needs to have an effective and well-designed website, in order to justify its rationale, attract visitors, showcase its importance in the social life of a specific area and a nation. Day (1997) and Cunliffe et al. (2001) posit the argument that the specific goals and objectives of the museum should be reflected on the website. One such goal is preservation of artifacts and Mason and McCarthy (2008) argue that a strong relationship can be ascertained between museums and computers and other digital tools over the last two decades, created to preserve data and digitize collections for better storage.

Online resources can augment engagement facilities of museums (Wilson, 2011). This is not just limited to websites, but also downloadable apps and interactive exhibits. Davies (2007) and Yasko (2007) argue that the virtual space is in fact an extension of the physical space with enhanced opportunities for visitors to interact with objects in the museum, with access to digitized collections and virtual tours. With greater presence in social media, museums have also started communicating directly with their potential audiences by posting videos, updating information related to exhibitions, and discussing recent developments in the fields which are a part of the core exhibits of the museum. A very good example of this is the website of the California Academy of Sciences which gives access not just to the content of the museum exhibits but also to all the recent breakthroughs in the world of science[4]. The institution also maintains active Facebook,

[4] http://www.calacademy.org/ and http://www.calacademy.org/explore-science

YouTube and Twitter accounts, which are used to constantly communicate with audiences from around the world making them aware of cutting-edge research in traditional and new scientific disciplines.

It is fascinating that one of the most succinct explanations of the potential of websites is to be found in an early document of the Museo della Scienza, back in 1995[5]. The document proposed certain characteristics that a successful website must possess, which are still relevant today even with the continuous advancements in the field of web technologies. These features include: dynamism (the ability to update information at a swift pace), hypertextuality (the possibility of creating linkages between articles and webpages both internally and externally), interactivity (considered as the most important ingredient for the success of the website) and the use of direct voice (the need to address the visitors informally).

As mentioned earlier, while there is a growing body of research on web history and some specifically focusing on museum websites, the history of these websites have largely been neglected by museum studies. Mason and McCarthy (2008) astutely observe that discourses about new technologies generally are presented in overtly theoretical and under-historicized styles. Where we depart from Mason and McCarthy is however when they claim, quoting Henning, that new media "like old media, is best understood as 'a means to organize and structure knowledge and visitor attention, not as a means of communication or a set of devices" (Henning 2006, p.303: Mason and McCarthy, 2008, p.64).' Our position, following communication theories, is that new media not only help in structuring knowledge, they embody information through technologies that are user-enabled and friendly. In new media theories, technology has increasingly been conceptualized as performative, conversational and primarily as a space where "perspectives are accommodated rather than stifled by an imposed ordering." (Srinivasan, 2012, p.206) As we will see in the diachronic analysis of the selected

[5] https://web.archive.org/web/20041217025646/http://www.museoscienza.org/INTERNET/prog1995.htm

websites, museum professionals have been aware of the performative and conversational aspects of new technologies.

In the following section we present the different sources we employed in our analysis of the changes in the layout, content and structure of the selected websites. In particular, the use of snapshots from the Internet Archive is discussed in detail.

3. Sources and Methods

In order to conduct our analysis, we employed three types of primary sources. First of all, we used snapshots of websites preserved by the Internet Archive, as these materials hold the potential of presenting the changes in layout, structure and contents of a website through time. Secondly, we conducted a series of interviews with the people who are managing the websites at present. By combining these sources, our goals were *(a)* to obtain a comprehensive perspective on the evolution of science museum websites and *(b)* to understand the reasons behind specific changes and decisions. We expanded our analysis further by adopting resources available on the live web. The live web includes the current version of the website and the presence of the museum on social media. In the following paragraphs, the reliability and potential of the different primary sources introduced above will be explained further.

3.1 Web archive materials

During its first 25 years, the World Wide Web has been constantly growing and today it presents the vastest collection of primary evidences of our past ever to have existed. However, at the same time, the web has also transformed constantly without leaving any trace (Brügger, 2005) and this has made its preservation and diachronic study extremely challenging for scholars.

Since the second part of the Nineties, initiatives have been taken by private (Lyman and Kahle, 1998) and public (Gomes et al., 2011) actors to preserve the web for future research. Currently through its Wayback Machine the Internet Archive offers the largest collection of preserved pages (Lepore, 2015). Moreover, in the last decade web archive

materials have been already used by media studies scholars, historians and political scientists for a large variety of research (e.g. Foot et al., 2003; Dougherty et al., 2010; Milligan, 2012; Hale et al. 2014; Ben David, 2015; Nanni, 2016). These different studies have revealed the great potential of web archives in offering new/different perspectives on our recent past.

In this work, we focused on a qualitative analysis of the web histories of the three websites introduced in Section 2. The preliminary step of this analysis was to create a collection of all the snapshots of the websites available on the Internet Archive. This was accomplished by using the Wayback Machine. We initially focused on studying the homepages of these websites over time, as they offer a general overview of the structural organization and highlight which subsections were considered highly relevant at specific points in time (for example, the ones listed in the sidebars). During this analysis we identified, in a coarse-grained fashion, all major changes in the structure and the layout of the homepages. Next, we examined the transitions between the layouts of each website, more specifically, how layouts changed over time and what were the main modifications. This helped us in recognizing, for instance, the subsections which remained linked to the homepage after a layout change, those which were removed and those subsections which were introduced.

After having performed this coarse-grained analysis of the three websites, we then examined the obtained results in order to detect *(a)* similar patterns in how the overall layout and structure changed over time, *(b)* correlations with other studies on the topic (e.g. Schweibenz, 2004) and *(c)* evidences of how new technologies (e.g. Twitter embeddable timelines) were integrated into the museum websites. The results of our fine-grained study helped us defining the narration and periodization of the three science museum websites, presented in Section 4.

3.2 Oral histories

As previously emphasized, while reconstructing our past will rely increasingly on born digital materials, they are extremely difficult to preserve in their integrity. For this

reason, although web archives will continue to be recognised as a relevant source in historical research in the next decades, a key role will be played by recording and preserving oral memories[6]. In fact, while snapshots from the Internet Archive can provide the 'what' of the website, i.e. they can help reconstruct the changes in the website's structure diachronically, oral memories will give us a better understanding of the 'how' and 'why' of those changes. These direct sources will, therefore, explain the rationale behind the changing architecture of the websites.

For our work we conducted oral interviews with the digital teams of the museums we chose as case studies. A set of qualitative, open-ended questions[7] were emailed to the website managers of the three museums, which were aimed at understanding the evolution of the websites. The qualitative data gathered from the interviews with Paolo Cavallotti (Head of Digital, Museo della Scienza, Milan), John Stack (Digital Director, Science Museum Group, UK) and Annette Lein (Head of Online Media, Deutsches Museum, Munich) will be discussed in conjunction with the findings of the in-depth analysis of the snapshots from the Internet Archive and of the live web.

3.3 The live web

While web archive materials and oral memories help us in reconstructing the changes in websites over time and in discovering the reasons behind specific transformations, materials available on the live web will also play an important role for future web historical research. The live web reveals the current role of websites in the museum's organization and management (e.g. attracting international visitors and promoting temporary exhibitions). Additionally, by combining materials from the websites and from social media pages of those institutions (such as Facebook, Youtube and Twitter profiles), we can make reasonable assumptions about the digital interactions between

[6] The importance of oral memories for web historical research has been emphasized both by Ahmed AlSum and Federico Nanni at IIPC 2015:
https://www.youtube.com/watch?v=AHrxvRWf9OM

[7] https://drive.google.com/file/d/0B3qiRI3zLcHtWFlHRFBYenlpc1U/view?usp=sharing

users and institution that have been established in recent years, outside the digital space of the museum websites. While materials from social networking websites will play a fundamental role in helping researchers to better understand the multidirectional communication in the first decades of the 21st century, it is important to remember that their suitability for historical analysis is currently under scrutiny, as preservation (Zimmer, 2015), computational (Webster, 2015) and reliability (Brugger, 2015) issues have to be considered and debated.

4. Diachronic analysis of the websites' past

We conducted in-depth analysis of the three science museum websites introduced in Section 2, adopting the combination of methodologies described in Section 3. Based on the results of the analysis, we propose a periodisation to track significant changes in the structure and functions of the websites, by dividing the timeline into four macro-phases[8]. The first phase covers the second part of the Nineties, when the websites were set up, primarily to provide information about location, collections and activities. The second comprises the years between 2000 and 2006, when a growing focus on the "virtual museum" and on the importance of interactions with digital representation of objects presented in museums could be detected. The third phase includes the years between 2007 and 2010, when the focus shifted from creating sophisticated version of the physical museum on the web, to forging better alliances with potential visitors through

[8] The idea of presenting the changes in the website in phases is inspired by the categories presented in Schweibenz's (2004) article on the development of museum websites. These categories include: the brochure museum (early website type which provides information for potential visitors), content museum (website which presents museum collections and allows visitors to explore them online), learning museum (website that provides context-oriented information about objects to enhance learning), and virtual museum (website which presents a version of the physical museum with digital collections). It must be noted here that Schweibenz's article, which was published in 2004, could not have envisioned the recent changes in the web, specifically the social media explosion.

blogs and similar participatory platforms. Given the extraordinary growth of social networking websites that has been prevalent in the last decade, we consider museums now fully entering the fourth phase (2011 to present), when the majority of the interactions and the dialogue with the user takes place on Facebook and Twitter and the website purports to be an extremely advanced digital interface to the collections and archives.

While this periodization has helped us shaping the diachronic narration of the changing in science museums websites over time, these phases should not be considered as watertight compartments because many old features continue to make appearances in the new versions. The periodisation is intended to show how websites can be traced as new historical sources, which are in a state of constant modification.

4.1 The 'leaflet' museum website

The early use of the website as an information leaflet of the museum corresponds with Schweibenz's (2004) analysis of the typologies of museum websites, in which he describes the first category as the 'brochure museum'. The definition of this type is given thus "...this is a Web site, which contains the basic information about the museum, such as types of collection, contact details, etc. Its goal is to inform potential visitors about the museum." This is, in other words, the initial identity of the museum website as described by Annette Lein of Deutsches Museum in the personal interview. Paolo Cavallotti of the Museo Scienza concurs: "The idea was to present the museum and its objects and collections. The website's main function is to present the museum aesthetically."

The following paragraphs present the results of our analysis of the early years of the three websites. In these years, the main goal of the websites was to function as a digital leaflet for the museum, in order to reach and attract potential visitors. In fact, materials presented on the websites include detailed textual descriptions of the museum's collections and information regarding temporary exhibitions, often available in more than one language.

The Museo della Scienza has been online since 1995, with an essential informative interface on the activities of the museum, its collections and the opening hours[9]. As it can be noticed from Internet Archive's snapshots, the first version of a more extended service was presented as early as in 1997: a 3D graphic interface was developed "in order to transmit the idea of an overwhelming variety of information"[10]. The homepage provided general information about the museum, its activities and on temporary exhibitions, both in Italian and English. Hyperlinks and descriptions of other international institutions, such as the Science Museum in London and the Deutsches Museum in Munich, were offered[11].

By studying the new contents that were added over time, we noticed that the museum offered a series of introductory guidelines for its users on topics such as the "Internet" and the "Web", in the second part of the Nineties. Teaching how to use new technologies (e.g. how to send emails) was also a key aspect in the collaboration between the museum and schools, as described in the "Scuole attività" (school activities) page[12].

At the end of the Nineties a first experimental version of "Leonardo Virtuale", a virtual tour of the museum, was presented online. This development marked the first step of the museum towards establishing a different presence online compared to the initial 'leaflet', and presenting its website as a parallel (digital) collection, which could be explored by users directly from home.

A similar path, focused on providing an overview of the collection and a series of practical information, could be detected in the initial years of the London Science

[9]https://web.archive.org/web/20001012004412/http://www.museoscienza.org/INTERNET/sito.html

[10]https://web.archive.org/web/20001012004412/http://www.museoscienza.org/INTERNET/sito.html

[11] This confirms further the strong linkages between the museums and explains further our choice of their websites as case studies.

[12]http://web.archive.org/web/19990903174023/http://www.museoscienza.org/SCUOLE/Default.htm

Museum website. The goal of the museum for its website, mentioned in the two reports published between 1998 and 1999, was to attract more visitors to the physical museum (by improving the structure and the usability of the website) and to improve its role for educational purposes[13]. Reading the first report, we also noticed that the interest of the museum was to develop a solution to offer a different browsing experience to different users.

In 1997, the Deutsches Museum website offered a similar homepage with several pieces of information, both in German and in English. From news regarding the museum, to descriptions of special exhibition to courses and seminar offered by this structure, this website could be identified as the paradigmatic version of Schweibenz's brochure website discussed earlier. Moreover, a multimedia section (available in 1997 under the rubric "dioramen") offered interactive demonstrations of specific expositions, videos and other contents. Great attention was paid to describe its archive devoted to the history of science and technology, one of the most important in Europe. Part of the catalogue was presented online and could be directly consulted by users. As pointed out by Annette Lein in the interview, in this early version of the website, "...the aim was to provide information for visitors and to present the exhibitions online with text and photos worldwide. Other main topics were: calendar of events, a list of people working in the museum, a glance at archives, library and research institute, feedback form, contact."

At the end of the Nineties, the leaflet type of museum website encountered a major overhaul in terms of image and content, aided greatly by the changes in software and

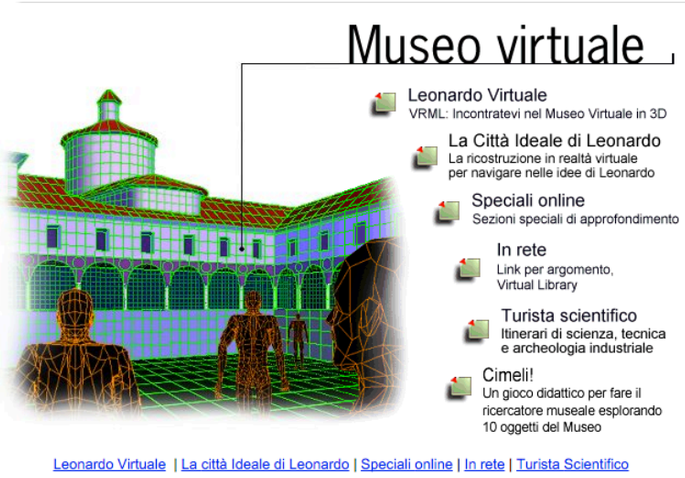
[13]http://web.archive.org/web/20000418181553/http://www.sciencemuseum.org.uk/usage/index.html

hardware technologies available to web managers. This phenomenon, together with the development of websites that permitted interactive tours of digital reconstructions of museum collections, signalled the beginning of a new phase. John Stack, the Digital Director of the Science Museum Group summarises this transition thus: “There is a general trend of museums initially thinking of their websites as a way to promote a visit to the museum. There is then an increase in considering the website as a destination in its own right and of therefore producing content for it such as digitized collections and other online resources.”

4.2 The rise and fall of the virtual museum

During the first part of the 2000s, a common trend characterized the efforts that the three museums focused on their digital space. Moving from a conception of the website as a series of pages where pieces of information regarding collections and archives were presented, they started experimenting with virtual reality. The goal was to offer new experiences to the user who would have the opportunity of interact with the collections directly from home.

In 1999, the Museo della Scienza introduced a virtual museum called “Leonardo Virtuale”, created in collaboration with the Polytechnic of Milan. Using this software, users could “walk” and “fly” through the different rooms of the museum and explore its collections. Visitors had the possibility of meeting and chatting with other guests and following a virtual guide. An innovative choice was to adopt Webtalk, a technology developed by the Hypermedia Open Center (HOC) of the Polytechnic of Milan based on VRML (Virtual Reality Markup Language) and Java, which guaranteed a real time interaction between different users.



In 2001 the London Science Museum also introduced the "Exhibitions online" section. Similar to a virtual museum, in this case visitors could explore the different collections from their desks, from Babbage's machine to Marie Curie and the history of radioactivity. Moreover, interaction with a series of objects was offered (for example, the possibility of exploring the Apollo 10[14] module).

The potential of the web as a place to interact with digital collections gave museum practitioners the chance of experimenting new forms of education. For example, the "Learn and Teach" section of the Science Museum presented several pieces of information for family and school classes and offered a series of activities that could be conducted from home[15].

Giving users the possibility of interacting with digital objects was a fundamental aspect of the changes in the Deutsches Museum website as well. As early as in 1998 a "Museum Multimedial" was created with a link available on the homepage. During the

[14]http://web.archive.org/web/20021002123300/http://www.sciencemuseum.org.uk/on-line/apollo10/intro.asp

[15]http://web.archive.org/web/20021001232233/http://www.sciencemuseum.org.uk/education/families/online.asp

following years this page offered a large variety of resources[16]: from dioramas to live-cameras, from video-clips to interactive demonstrations.

Even though all three science museums showed ample interest in offering interactive collections online (e.g. in the form of virtual tours), the realisation of the virtual version had to face serious technological impediment, which contributed to the demise of the trend of creating virtual museums. First of all, the majority of internet connections were not sufficiently fast and stable to fully support the usability of these services. Secondly, 3D graphic reconstructions were usually not accurate enough to be considered a real substitute to a visit to the museum. Discussing the diminishing popularity of the concept of the virtual museum, Cavallotti comments on the strategy adopted by Museo della Scienza: "This concept was very popular some years ago. But the museum's website team does not want to make a difference between the virtual and physical museum. The team uses digital tools to talk about the physical museum."

While the goal of creating a virtual experience of visiting the real museum have subsided during the second part of the last decade, the interest in digitizing content and presenting them in interactive ways to the user has remained, as is evident in new digital projects taken up by both the Deutsches Museum and Science Museum. The Deutsches Museum Digital project, as described by Lein, will provide online access to the entire collection of objects of the museum, and to the archives and the library[17]. Stack mentions that while they do not have a plan for a full-scale digital museum, they are participating in the Google Cultural Institute Gallery View Project. So will the early trend of virtual museums make a comeback with these kinds of current collaborative projects? Lein's observation tells us otherwise, as she makes a sharp distinction between the virtual museum and the digital museum. While the latter as a trend has subsided, the former has gained popularity as it can ensure better opportunities to interact with the museum online, due to multiple digitised collections being granted open access. Furthermore, the digital

[16]http://web.archive.org/web/20021019104649/http://www.deutsches-museum.de/mum/start.htm

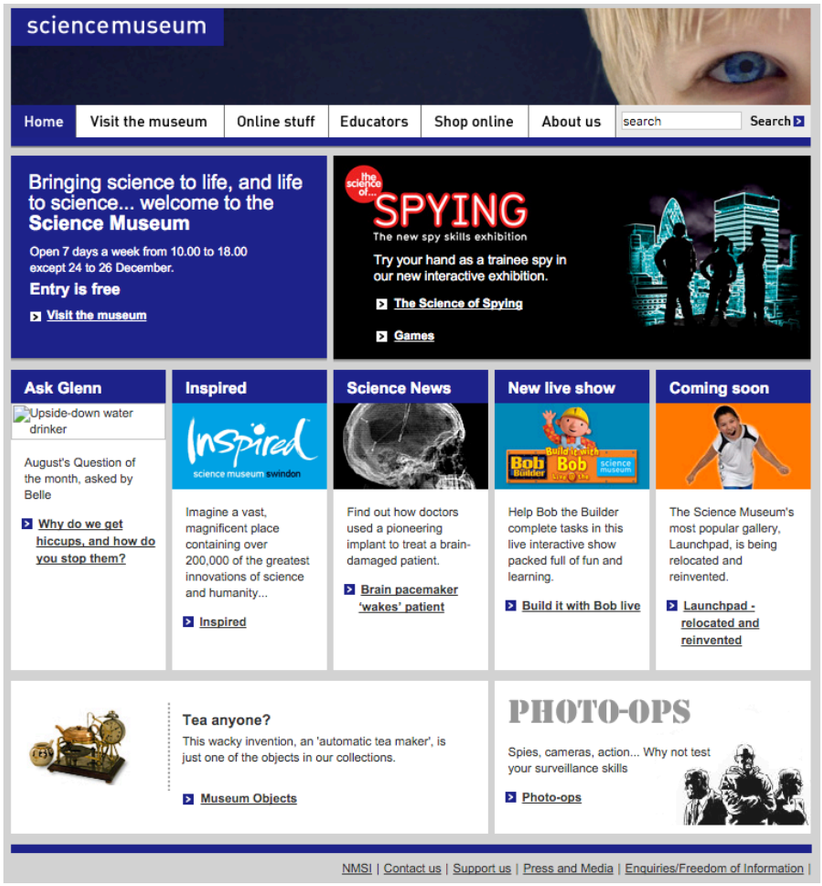
[17] http://www.deutsches-museum.de/forschung/deutsches-museum-digital/

museum consists of the website as well as the communication taking place on social media managed by the museum team.

4.3 The outreach-museum website: ensuring greater engagement

While the virtual museum as a trend had started waning by the middle of the 2000s, increased attention was being paid by website managers to present collections in innovative ways (e.g. enhancing digital collections and accurately describing them in dedicated blogs) and to improve communication and dialogue with the users. In museum studies literature, this was the period of increasing number of scholarly works being written about the concepts of participatory designs in museum exhibits, and co-participation of visitors in determining the content inside the museum space. Among them, *The Participatory Museum* (2010) by Nina Simon explains in detail how greater visitor participation can be achieved. She argues that authority over content should be shared between the museum and its visitors, citing O'Reilly's definition of Web 2.0, "an application that gets better the more people use it."[18] Following the greater focus on more inputs from the public as emphasised by Web 2.0 theories, the websites examined in this chapter show similar structural changes at this stage of the decade to accommodate more voices.

[18] See http://www.participatorymuseum.org/chapter3/



Museums have offered snippets of information regarding their collections and new exhibitions to their users, in particular through newsletters, since the Nineties. However, during the second part of the 2000s there was a greater focus on communicating through blog posts and podcasts to go beyond the traditional authoritative role of these institutions. An excellent example was the Science Museum's "Antenna", a constantly updated resource for science news. Blogs describing the collections were also developed, as the "Stories" from the Science Museum and "Der Blog das Deutsches Museum" shows. The second one, which has been regularly updated since 2009, has been mainly written in German, highlighting their target users.

While blog posts represent a continuation of newsletters and updates regarding collections, an alternative way of presenting the museum online is to employ social networking sites to share photos and videos. In 2006 the Science Museum opened a Flickr account that was intensively used until 2015 (more recently the museum started using Instagram for sharing pictures and short videos). Between 2007 and 2008, interest in Youtube resulted in the three museums opening accounts, where they have been

constantly sharing interviews and videos regarding exhibitions. In the last years, the possibility of assuring multidirectional dialogue between museums and users has become one of the central aspects of the online activities of our three case studies, as evident from the activities on the social media profiles of the three institutions. We thus propose that these websites are now entering a new phase, where their social media profiles have become the most frequented spaces to directly interact with visitors.

4.4 The social-media website: managing large networks of communication

Science museums have been constantly trying to improve communications with their visitors since Nineties, through emails and online forums in order to improve interaction with visitors. This could be seen, for example, in the "Let's Talk" section of the Science Museum in 2002[19]. The aim of this section was to answer questions, to create discussion forums about scientific themes and to receive specific feedbacks.

More recently however, these institutions decided to use two of the most frequented social networking websites (Facebook and Twitter), which allow many to many communication. By 2011, all three museums have been using Twitter and Facebook for greater engagement with users. On social media, the Museo della Scienza[20] and the Deutsches Museum are primarily communicating with their national audience, as can be noticed by the language of the posts and tweets. The Science Museum, which was actively using both Facebook and Twitter already in 2009, represents a good example of how to use social media to communicate with the visitors using specific thematic news, hashtags and photos. The digital department has also launched a mobile version of the website, to cater to a very large audience who frequent the web using their phones.

In recent years, while social media interactions are being managed carefully, the website has returned to be an extremely advanced digital presentation of the institutions

[19]http://web.archive.org/web/20021004110407/http://www.sciencemuseum.org.uk/lets_talk/index.asp#

[20] Cavallotti mentions that the Museo Scienza has hired a social media personnel on a part time basis from 2015.

and their collections. Attention has been paid to develop online scientific games, interactive apps and thematic sections. At the same time, prominent links to the social media pages are always present on the homepage. Lein observes: "Facebook, YouTube, Twitter are the important social media channels – the press office is responsible for the accounts. We closely work together, plus there is the Museum Blog[21]." Stack's comment about the strategies of the London Science Museum sums up those being adopted by leading European science museums to upgrade their facilities, which are reflected online and offline: "We are looking at increasing digitization of collections, using digital media to tell the stories of the collections and to engage audiences with contemporary science through social media."

Given that social media is gradually becoming the main dialogic space for museums and visitors, we also need to consider that content generated in these networking spaces will not necessarily be completely available to the museum for specific analyses. In fact, while large amount of user-generated data in these social networking sites can help museums to engage better with the public (e.g. by carrying out large scale visitor surveys), efforts have to be made to obtain them from the parent companies. The history of museum websites in the recent future will not only be contained in the preserved snapshots of their website's pages, but also will be found on the walls and the tweets shared among interested groups.

5. Conclusion

The purpose of this chapter has been to offer an initial contribution towards the formulation of a methodology for studying websites as primary sources to trace activities of scientific institutions through time. Documents and snapshots preserved in the Internet Archive can help us trace how the websites have evolved over the years, while interviews with the people who manage them can provide useful insights into the reasons behind specific choices as to why certain changes were made. The live web also has to be

[21] http://www.deutsches-museum.de/de/blog/

consulted as it helps us track the current versions of the sites, and their linkages with other social networking sites. The use of all three methods together is important when reconstructing the digital past of the websites, especially in order to address reliability issues discussed intensively in web history literature, i.e. the fact that archived websites are "re-born digital materials" (Brügger, 2012).

Apart from contributing to the methodology of studying websites through time, this chapter also proposes a periodisation of museum websites in four macro phases, namely the leaflet museum, the virtual museum, the outreach museum and the social-media museum. Our findings show how these institutions, traditionally viewed as authoritative, top down entities, have constantly worked towards developing websites that go beyond being informative, which have in turn become the central node of an interactive, multidirectional communication between the museums and their visitors.

References

Bowen, J. P., Bennett, J. & Johnson, J. (1998). Virtual Visits to Virtual Museums, In D. Bearman and J. Trant (eds.), *MW98: Museums and the Web Conference,* Toronto, Canada.

Ben-David, A. (2012). The Palestinian diaspora on the Web: Between de-territorialization and re-territorialization, *Social Science Information,* 51 (4), 459-474.

Ben-David, A. (2015). What Does the Web Remember of its Deleted Past? An Archival Reconstruction of the Former Yugoslav Internet, *Two-day conference at Aarhus University,* Denmark.

Bowen, J. P., & Filippini-Fantoni, S. (2004). Personalization and the Web from a Museum Perspective, *Museums and the Web Conference*.

Brügger, N. (2005). Archiving Websites, *General Considerations and State*.

Brügger, N. (2010). *Web history,* Peter Lang.

Brügger, N. (2012). Web historiography and Internet Studies: Challenges and perspectives, *New Media & Society*.

Brügger, N. (2015). A brief history of Facebook as a media text: The development of an empty structure, *First Monday,* 20 (5).

Cunliffe, D., Kritou, E., & Tudhope, D. (2001). Usability Evaluation for Museum Web Sites, *Museum Management and Curatorship*, 19 (3), 229–252.

Davies, A. (2007). Virtual museums: Out of this world. *Museums Journal*.

Day, A. (1997). A model for monitoring web site effectiveness. *Internet Research: Electronic Networking Applications and Policy*, 7(2), 109–115.

Dougherty, M., Meyer, E. T., Madsen, C. M., Van den Heuvel, C., Thomas, A., & Wyatt, S. (2010). Researcher engagement with web archives: State of the art. *Joint Information Systems Committee Report*.

Foot, K., Schneider, S. M., Dougherty, M., Xenos, M., & Larsen, E. (2003). Analyzing linking practices: Candidate sites in the 2002 US electoral Web sphere, *Journal of Computer-Mediated Communication,* 8 (4).

Gomes, D., Miranda, J., & Costa, M. (2011). A survey on web archiving initiatives, *Research and advanced technology for digital libraries*, pp. 408-420.

Hale, S. A., Yasseri, T., Cowls, J., Meyer, E. T., Schroeder, R., & Margetts, H. (2014). Mapping the UK webspace: fifteen years of british universities on the web, *Proceedings of the 2014 ACM conference on Web science*.

Henning, M. (2006). *New media - A companion to museum studies*, ed. Sharon MacDonald.

Howell, B. A. (2006). Proving web history: How to use the Internet Archive, *Journal of Internet Law*, 9(8), 3-9.

Lepore, J. (2015). The Cobweb: Can the Internet be archived?, *The New Yorker*.

Lyman, P., & Kahle, B. (1998). Archiving digital cultural artifacts. *D-Lib Magazine,* 4 (7).

Marty, P. (2007). Museum Websites and Museum Visitors: Before and After the Museum Visit, *Museum Management and Curatorship*, 22 (4), 337-360.

Mason, D.M., & McCarthy, C. (2008). Museums and the culture of new media: an empirical model of New Zealand museum websites, *Museum Management and Curatorship*, 23 (1), 63-80.

Milligan, I. (2012).Mining the 'Internet Graveyard': Rethinking the Historians' Toolkit, *Journal of the Canadian Historical Association/Revue de la Société historique du Canada,* 23 (2), 21-64.

Milligan, I. (2015). Welcome to the GeoHood: Using the GeoCities Web Archive to Explore Virtual Communities, *Two-day conference at Aarhus University,* Denmark.

Morrison, J. (2006). Cultural websites: Making the network, *Museums Journal*.

Nanni, F. (2017). Reconstructing a website's lost past - Methodological issues concerning the history of www.unibo.it, *Digital Humanities Quarterly*.

Schweibenz, W. (2004). Virtual museums: The Development of Virtual Museums, *ICOM News Magazine*, 3 (3).

Simon, N. (2010). *The participatory museum*. Museum 2.0.

Srinivasan, R. (2013). Re-thinking the cultural codes of new media: The question concerning ontology, *New Media & Society*, 15 (2), 203-223.

Webster, P. (2015). Will historians of the future be able to study Twitter?, URL: http://peterwebster.me/2015/03/06/future-historians-and-twitter/

Wilson, R.J. (2011). Behind the scenes of the museum website, *Museum Management and Curatorship*, 26 (4), 373-389.

Yasko, J. (2007). Museums and web 2.0, *Museum News,* 43 (7).

Zimmer, M. (2015). The Twitter Archive at the Library of Congress: Challenges for information practice and information policy, *First Monday,* 20 (7).