Digital History of Virtual Museums:
The Transition from Analog to Internet Environment

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Abstract. Many thousands of virtual museums exist on the Internet, demonstrating very diverse and significant museum resources, showcasing the treasury of humankind. These resources have come a long way in their evolution over past decades. The history of virtual museums began long before they appeared on the Internet, and the concept of virtual museums needed to be established in order to become an essential and effective means of accomplishing new museum functions in the digital age. Through the designing of such a concept, the creation and development of museums' information resources, websites and various digital initiatives have become the keys to the success of museums in the digital environment today. This article considers the concept of a virtual museum, traces the transition of virtual museums from analog and interim multimedia formats to the online environment. The author surveys the crucial moments in the history of virtual museums and the stages of their development from the digital turn to their appearance on the Internet and subsequent transformation after this transition. In this article examples of museum information resources from North America and Europe, Japan and Australia are traced back to the first virtual museums online in the 1990s. Based on the analysis of materials from web archives, strategies for creating the first virtual museum resources on the WWW are identified.

Keywords: Virtual museum, Museum Multimedia, Web Archive, Museum Studies.

1 Introduction

Virtual museums that date from the mid-1990s are often thought of as naive, or superficial. But was this really the case? Could their emerging complexity be hidden behind the simple interfaces of the first online resources? These questions do not have simple answers, since the digital turn in museums began long before the advent of the Internet, and museums had already gained extensive experience in creating multimedia products for users and were therefore ready to some extent for a new challenge of the Internet.

The use of information technologies in museums, growth of the information environment of the GLAM (galleries, libraries, archives, and museums) sector, digitization and development strategies of digital collections, and introduction of interactive

technologies have long been the focus of attention of researchers; this history is much longer than that of online museums. Particularly valuable in the context of this study are works related to the history of museums in the digital age. Thus, chapters of the volume "Museums in a Digital Age" [1] show how museums respond to the challenges associated with innovative digital approaches and how the ways of interacting with the audience are changing. Erkki Huhtamo's article [2] focuses on the early history of virtual museums, the origin of virtual museums, and the evolution of exhibition design. The author pays considerable attention to the development of new media, which had a direct impact on the restructuring of museums and the creation of forthcoming virtual museums. Based on a study of web archives, Jonathan P. Bowen's article shows the first virtual museums, analyzes a set of digital museum resources, including those distributed on CD-ROM [3]. This article has a more technological approach to the history of museum web space and focuses on the author's personal experience in developing a virtual library, the first system of "documenting" online museum resources. The author exposes the example of two early museums online and shows virtual museums in the context of the history of computing. It should also be noted a significant paper by Paul L. Arthur [4] examines the development of interactive technologies in real and virtual museum spaces in a historical perspective.

In general, we see that several important directions of the history of virtual museums and technological innovations successfully introduced into museum resources at different stages of their development are presented in historiography of digital history of virtual museums. This study attempts to trace the continuity of the stages in the development of virtual museum resources from the beginning of the digital turn in the museums to the emergence of the first virtual museums on the World Wide Web.

The main sources for this study are proceedings of conferences focused on the application of information technologies in the GLAM sector and publications by professional organizations (International Council for Museums (ICOM), Museum Computer Network (MCN), Network of European Museum Organizations (NEMO), Computer Applications & Quantitative Methods in Archeology (CAA), International Cultural Heritage Informatics Meetings (ICHIM), Museums and the Web Conference (MuseWeb), museum reports. The early online history of virtual museums has been reconstructed from data from web archives such as Internet Archive "WayBack Machine" and "Archived websites" at the source of National Library of Australia "TROVE".

2   What is a Virtual Museum?

Currently, ICOM is working on the revision of the definition of the concept of "museum", because the previous one is outdated and no longer corresponds to state-of-the-art realities. And since there is no consensus on the essence of the museum, it is also premature to talk about a common understanding of the essence of a virtual museum. There are a variety of interpretations of the term "virtual museum", as there are concepts used along with it, such as digital museum, web museum or online museum. Often, the same term refers to completely different contents, for example, the section "virtual museum" can include different information resources the virtual tours on a

real museum environment or digital collections of objects. Here I draw attention to the fact that an exhaustive definition, or a definition that suits all stakeholders, such as museums, content developers, researchers, users, cannot be given, since there is no taxonomy of the concepts related to the interdisciplinary field of information technology and the museum sphere. Creating one definition is also difficult because there are a variety of types of virtual museums [5].

The first information resources were often called virtual museums, although they were in fact landing pages of existing museums advertising exhibitions held in these institutions [6]. It is obvious that there is a whole set of different types of museum information resources that involve different contents.

The VIMM research team has developed the following definition of the term "virtual museum": "A virtual museum (VM) is a digital entity that draws on the characteristics of a museum, in order to complement, enhance, or augment the museum through personalization, interactivity, user experience and richness of content" [7]. In general, agreeing with the definition above, we add that in our view, the modern virtual museum is the most comprehensive museum information resource that allows museums to solve various museum tasks and implement various museum functions in a digital environment.

However, virtual museums have gone through a long period of evolution, becoming more complex and developing further all the time. And of course, at each stage of development they implied relates to different complexity of content. In this study, we adhere to an extended interpretation of the term "virtual museum" as a new type of product, distant from a real museum space by information technology means. The virtual museum, as a new media product, as shown in the article by Erkki Huhtamo [2], is a product that originated in the pre-digital era, and therefore has a direct relationship to the new reality, different from the museum's space in its physical space, as well as to the reproduction of museum objects for their alongside with the use of authentic objects.

3   Digital Turn in the Museums

The digital turn in museums was part of the digital turn of using computers and information technology for human needs. This became possible thanks to the development of cybernetics, computer technology, and a turn towards humanity was indicated in the early 1950s by Norbert Wiener (1894–1964), the founder of the theory of cybernetics, in the book "The Human Use of Human Beings" [8].

The 1960s were significant for the GLAM sector in terms of developing the first projects related to the use of information technologies in museums. During this period, the realization occurs of the need for collaboration between GLAM-organizations, IT-companies and academic institutions. In 1967, the Museum Computer Network (MCN) appeared as the initiative of the Metropolitan Museum of Art (New York, USA), which initially brought together 15 museums, but the number of participants in the network began to grow rapidly. MCN is a currently functioning non-profit organization, a professional association whose goal is to support the development of the

museum sector in terms of the use of information technologies in various areas of museum activity. The mission of MCN is "to grow the digital capacity of museum professionals by connecting them to ideas, information, opportunities, proven practices, and each other" [9].

In April 1968 the first Conference on computers and their potential applications in museums was held at the Metropolitan Museum of Art with the support of IBM Corporation. The discussion at the conference focused on key topics including the possibilities of using information technologies for processing data from storage facilities, the creation and implementation of museum information systems, the use of computer technologies in data analysis, and the prospects for graphical visualization systems [10].

At the same time, the creation of a professional organization, and the holding of specialized conferences, contributed to the institutionalization of the new direction, stimulated cross-sector communication, cooperation of various organizations in this field, supported the exchange of experience, and promoted the first experiments in the new field.

In the 1970s and 1980s, information systems for documenting and cataloging were distributed, which gradually became an integral part of the functioning of museums. The development of these systems has revealed the need to present images that were originally requested by curators to facilitate the creation of exhibitions. Naturally, the level of technology development was such that the quality of digital photos of that time did not satisfy the demands, but experiments in this area progressively prepared the way for the development of digital museum content and revealed the potential for its representation through virtual museums.

In 1983, the Museum Documentation Association conducted a survey of decision-makers from UK museums using computers in their activities. The results of the survey have identified that most museums use cataloging and accounting systems, administration systems, specific programs for organizing data (databases) and collection management software packages [11]. However, most catalog systems, documentation systems were not intended to visualize museum objects, which prevented the expansion of their use.

In the description fields of such systems, instead of the image, the number of negative image of the object from the physical storage was simply indicated [12]. In addition, the serious issue was related to the limited space of magnetic disks on which information was stored and the constant need to control their size so that the storage of information of existing systems was stable [11]. Another significant limitation for the first museum experiments with computers was the high cost of the computers, software and the work-expenses of the IT-professionals [13]. Therefore, the formation of a new museum audience among computer users at that time was problematic.

4   The Age of Museum Multimedia

Virtual museums today aim to be able to reproduce museum objects by creating digital products for presentation to the public. Museum experiments with multimedia

have emerged from the concept of A. Malraux of a museum without borders [14]. The idea of André Malraux was based to some extent on Le Corbusier's earlier ideas [15] about an endless museum, the expansion of which is possible constantly, for which a whole series of architectural solutions was proposed.

In the museum without frontiers, space is not limited to physical galleries and exhibition spaces, museum activity is not confined to the space of a real museum, it reaches new audiences by promoting research, curatorial and other projects, publishing and distributing catalogs, reproductions, books, slides, microfilms containing reproductions of museum objects, information on exhibitions. Radio programs are created, films are created with the participation of museums for television broadcasts and movie rental industry, which are subsequently distributed on various mediums. In the 1970–1980s, the shooting the videos of exhibitions, artists, curators and other topics related to museums was practiced by museums quite widely. Turning to the example of The Museum of Modern Art (MOMA), the earliest record in the video catalog dates back to July 1977. From that moment in the 1970s, 29 records were created, and during the 1980s are 97 [16], which illustrates the museum's initial activity in the production of a new product and maintaining the pace over these nearly one and a half decades.

The idea of the museum without frontiers was continued by the concept of an "expanded museum". Experiments with multimedia, alternative ways of presenting museum collections created a new space, separated from the physical museum, in which it became possible for the viewer to interact with reproduced museum objects. Nicolas Negroponte and Steve Gano, who worked on the opportunity to ensure the interactive nature of museum multimedia in the 1970–1980s [17] can be called the pioneers of interactive museum multimedia. Gano posed a key task for developers of museum multimedia in the need to create such a digital product that even a layman can use [18].

Transition from analog video formats to interactive multimedia content was noted by J. L. Sheldon, who began to use the term "value added video" as an increment to a simple video of a previous period [19]. J. L. Sheldon has created two interactive multimedia discs for the Addison Gallery of American Art. One disc included a specially created video, based on numerous plates with fragments of horse movement from the Muybridge collection. The museum could not put these records in the traditional exhibition due to their huge number and the inability of the audience to "grasp" the essence of what is happening, it seems that there are practically no changes in the freeze frames, the horse's movements are repeated, the exhibition space is limited [20].

Sheldon transferred the Muybridge collection into motion, through shooting images of the horse and making an animated film. The created computer disk was used in the exhibition space of the museum; 35 people could watch the film at the same time. The disk's interface had been programmed that externally resembles a book, which is easy to navigate in chapters. The user could select the desired scenes and animations for viewing from the four main sections of the disk and display them on the computer screen. The created video disc and interactive multimedia organically supplemented the space of the museum, strengthening its exhibition concept.

Another interactive multimedia disc was dedicated to the sculptor Harold Tovish and his work for an upcoming personal exhibition. Capturing video, it was possible to present three-dimensional objects, fragments of documentaries about the work of the sculptor in his studio, as well as a catalog of his works. The catalog was an important component of this "video disc", which included the sculptor's works in collections from various institutions, public and private collections.

The catalog also included images of some lost sculptures (the sculptor had destroyed some of them, but photographs of these objects were preserved), sketches, drawings and prints. The sculptor's works themselves pushed for animation and the use of movement, since they themselves seemed to be in motion, looked "frozen" for a second [21]. Not surprisingly, works by this particular sculptor were chosen to create the disc as part of Motion Studies by Sheldon. The disk became an iconic multimedia product, as it presented opportunities for the study of the sculptor's work by a wide audience. The created disk provided for wide possibilities of its use outside the gallery walls and the disk was created taking into account its use on inexpensive, widespread computer platforms.

Wider distribution of museum multimedia products on CDs became possible with the microcomputer revolution. A powerful technological breakthrough, the widespread availability of a personal computer, and the reduction in cost of technology have allowed museums to more actively expand their activities and audience. The microcomputer revolution has given impetus to the development of an entire industry of interactive museum multimedia.

In the early 1990s museum multimedia soared, and disks became one of the best museum's souvenirs as an opportunity to bring along some impressions from the museum. Museums were actively involved in the process of creating interactive multimedia discs with the presentation of unique exhibits and a variety of stories. This process went along with the digitization of museum objects, the creation of catalogs and the filling of museum documentation systems, which at that time were already capable of presenting digital copies of objects.

The compact disc "Treasures of the Smithsonian" [22] was recognized as one of the best museum multimedia products, received the "Muse Award" in 1991 from the American Association of Museums. The disc contains the most interesting objects in various formats (images, audio and video) from the Smithsonian museum collections. The user got the opportunity to search and sort "treasures" by museum, category, chronology and theme, read additional information about collections, objects, their authors, circumstances of creation, zoom in or zoom out. The disc was intended for a wide audience, where many very different people could find something interesting for them. The disk was intended for personal use on a PC or in standard CD–players, which were widespread, or were often embedded in a TV. The authors have successfully solved the problem of intuitive use and the ability to view information in any order.

Interactive multimedia implemented several fundamentally important features, such as creating a user interface, organizing content based on a database, linking visual images to their description, and the presence of clear and simple instructions for use. The user has the opportunity to choose the order to follow in the study of materi-

als, since it was implemented dividing the video stream into fragments, the ability to select the desired fragment, regardless of order. These features made it possible to realize the personalization of choice. Interactive multimedia demonstrated new ways of re-presenting museum content that changed the perception of a museum object or collection by user, since it was possible to develop and deepen the contexts in which a given object or group of objects could be presented and used.

5 Towards virtual museums online

The first experiments with the integration of museum computers into a network began in the 1960s, associated with the activities of the American Museum Association. Museum professionals quickly became aware of the benefits of networking such as creating common information systems and maintaining integrated catalogs, higher speed of data exchange and processing, efficiency in accessing information, new opportunities for curators and organizing exhibitions due to their greater accessibility to information. Gradually, such online databases are more widely distributed and are used in North America and Europe. Commercial projects are also interesting, such as the online data base ArtQuest, which was created in the early 1970s and included information on art objects put up for sale at auctions. Search capabilities were also significant because it was possible to search and sort information by the author of the work, the period of creation, name, price, presence or absence of images in the catalog [23].

At the MCN conference in 1989, a report was presented on the use of LAN (Local Area Network) in the museum field [24]. Multimedia stations are distributed in public spaces, connected to networks for remote access to resources [25].

Thus, by the beginning of the World Wide Web, the idea of network access to the resources created by museums had been tested both in terms of technology for creating networks and in terms of creating resources for data exchange. Virtual museums as a multimedia product were not something fundamentally new from the point of view of the presented content, much had already been "invented" earlier. The production of museum content for use outside the museum (as it was with museum films and multimedia for a wide audience) posed fundamentally different tasks for the museum such as creating special adapted content that does not imply the presence of a physical museum near the visitor, but allows the content consumer to delve into the subject, to feel this museum without borders.

The Internet has revolutionized museums' development, but it cannot be said that it occurred quickly. Technological limitations were a large problem because museums simply could not put already created resources into access. In the headings of some sites there are such concepts as "virtual museum" (for example, Diego Rivera Virtual Museum [26]), "Museum Online" (for example, Australian Museum Online [27], "Museum Explorer" (for example, The Queensland Museum Explorer [28]), "Web museum" (for example, Web Virtual Art Museum [29]). Despite the promising names, many of the first museum information resources were the simple web pages with brief information about the real museum and its collections, self-promotion, a

call to visit real museums that are not related to the virtual museum as we understand it. Virtual museums become so when gain greater functionality, allowing users to use the resource, regardless of the physical availability of a real museum.

6 Strategies for Creating the First Virtual Museums on the World Wide Web

There were several strategies for creating the first virtual museums represented on the World Wide Web. Museums as institutions for the storage of unique and valuable objects of historical and cultural heritage began to create web resources designed to represent the museum through the most interesting or even iconic exhibits and collections. Often these were separate images of objects that most vividly and succinctly illustrate certain topics. Some resources could include an image of an important object, accompanied by text, and so illustrate the story, giving historical references and explanations, or offering the user a wider context. Frequently, the creators of the resources did not even accompany these illustrations with metadata about the object, not considering it important to supplement the history or information about the collection with a description of the images, believing that the images were impressive enough (for example, the Canadian War Museum [30]).

Some virtual museums that were being created can be compared with the "curiosity cabinets" of the 17th – 18th centuries, since the new resources emphasized the features of the object, thanks to new interesting forms of their implementation such as animations that stimulated the cognitive interest of users. Some museums have tried to use the previously accumulated multimedia content and transfer it to the online environment. For example, the creators of Deutsches Museum [31] uploaded to the created resource multimedia clips about the first machines and engines (such as the first Diesel engine, "Puffing Billy"), which needed to be downloaded for later viewing on a computer using preinstalled software. The animations, although rather short, made a positive impression with their dynamism. Other multimedia materials were placed in a similar way, to which was added a corresponding textual description with explanations of the presented objects and their use. The attempts of the first interactive online experiments implemented by the Deutsches Museum in the 1990s are also interesting. Several interactive online experiments were placed on the resource, including those that made it possible to "control" the plasma by changing the direction of its flows, measure the thermal radiation of an incandescent lamp, track the properties of electromagnetic waves or see the "bends" of electron beams [32].

At the advent of the Internet, other museums sought to surprise the user with technological innovations, and implementation was sometimes more important than the content itself. Thus, the Museum of Fine Arts (Houston, USA) [33] along with other images posted four stereoscopic images with the Museum's garden, but did not provide them with an additional description. It was assumed that the user, using stereoscopic glasses, would consider these images for entertainment.

The publication of multimedia on virtual resources was not widely spread, since many multimedia resources were created on the basis of partnerships with other or-

ganizations such as the IT-companies and academic institutions and could not be used due to copyright restrictions. Also, Museums could prefer to continue usage multimedia for commercial purposes and were not ready to put them in open online access.

A widespread strategy for creating virtual museums was the creation of web sites that were designed to display the created resource as a virtual "copy" of a real museum space. In such virtual museums, objects and collections are located by analogy with the real museum's building, the plan of the museum was visualized, which could be followed by studying the exhibitions. In some cases, the museum plan was presented in a kind of three-dimensional space. Such a virtual museum is, for example, the Canadian Museum of Civilization Corporation [34], whose early versions contain an image of the museum plan, which is proposed to be followed when studying museum exhibitions. Images of museum objects with their brief description are presented on the resource as museum objects. The metaphor of the museum as a special historical building can be traced even in the design of the interface, the home page of some virtual resources, such as NTT Digital Museum (Japan) [35], on the front page of which there is a spiral staircase and columns of an ancient building.

Virtual museums were not always created by and with the participation of real museums. Some of the virtual museums were created as educational projects, based on the metaphor of the museum as a special institution in the form of a building in which the halls are dedicated to individual topics and represent museum objects. So, in the Art History Virtual Museum, created by The School of Humanities and Social Sciences at Charles Sturt University (Australia) with the support of Open Learning Australia, the metaphor of a real museum space is used to study the History of Art [36]. This paper does not consider the topic of correctness to call such resources virtual museums if they were created without the participation of storage institutions. We only note that in this case the term "virtual museum" refers the user not only to virtual content brought from museums, but also to virtuality in the sense of "unreality" of the virtual museum itself. The "virtual museum" was made with the transfer of the metaphor of the museum with its structure in the form of floors and thematic halls (rooms). Each "room" contains a list of images with brief metadata (metadescriptions), including designation of the name of the work and the place of its storage, as well as links to the museum web resources where the object itself was presented.

7 Conclusion

The digital history of virtual museums has gone through a long period of evolution from the first experiments with new technologies, the creation of multimedia products to adapted content available on the Internet. Museum multimedia laid the foundation for an alternative representation of the museum itself and its collections in a new space, which allowed for literally expanding the frontiers, going beyond the physical space of the museum, and finding new audiences in the virtual world. The idea of a new type of virtual museum, an interactive digital museum, was formed. The first experiments were created in which the user ceases to be a passive observer, the viewer, but becomes a participant, getting involved in the first experiments with the inter-

active resources. The fundamental aspect in the development of multimedia, hypertext and hypermedia technologies was the ability for the user to choose the paths of his or her selection of museum material, choose the order and priorities of interaction with accessing cultural heritage more closely, make requests to the created material, and not just passively observe the selected objects.

Designers of virtual museums, GLAM-institutions, IT-companies, developers and other stakeholders faced a number of challenges, including conceptual, theoretical and technological issues. Numerous discussions of museum professionals took place, which raised important questions about the virtual museum of the future. An important concept has since emerged of the virtual museum as a complex resource that has independent significance and potential to make positive impacts on human life and knowledge of cultural heritage.

8   Acknowledgements

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