



Museum Web search behavior of special interest visitors



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ABSTRACT

There is a current trend to make museum collections widely accessible by digitising cultural heritage collections for the Internet. The present study takes a user perspective and explores the characteristics of online museum visitors' web search behaviour. A combination of quantitative and qualitative methods was deployed in a case study at a National Museum of Military History. Quantitatively, data from a web questionnaire survey and a user study of interactive searching behaviour were collected and analysed. Qualitatively, observation protocols were coded and analysed based on inductive content analysis. It was found that metadata elements on factual object related information, provenience, and historic context was indicated to be relevant by the majority of the respondents, characterising the group of special interest museum visitors as information hungry. Further, four main characteristics of online museum visitors' searching behaviour were identified: (a) searching behaviour has a strong visual aspect, (b) topical searching is predominantly exploratory, (c) users apply broad known item searches, and (d) meaning making is central to the search process.

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1. Introduction

A current trend is to make museum collections widely accessible by digitising cultural heritage collections for the Internet, building on the idea of the visitor-centred museum (Anderson, 2004). Online visits to museum websites have become popular and some museums report that the number of online museum visitors exceeds the number of visitors to the physical museum (e.g., Fantoni, Stein, & Bowman, 2012). This raises the question of how visitors search, use, and interact with online museum collections.

2. Problem statement

Even though extensive literature examines visitor behaviour in the physical museum (e.g., Black, 2005; Falk & Dierking, 2000; Semper, 1998), studies of museum web site visitors have primarily focused on demographic characteristics, user segmentation, and technical details of the visit taking a quantitative departure. In response, there has lately been a call for a user-centred approach to the study of how digital museum resources are used, as well as a call for increased studies of a wider variety of users (Ellenbogen, Falk, & Goldman, 2008; Jørgensen, 2004; Marty, 2007, 2008). Motivated by this call, the present case study takes a user perspective and explores the characteristics of online museum visitors' information searching behaviour. The case study adds to understanding of *why* online museum collections are used; but the study primarily explores *how* users interact with online museum

collections. The focus is on what Booth (1998a) denotes as special interest museum visitors and the following research questions guided the study:

- What characterises information searching behaviour of special interest online museum visitors?
- What characterises visitor motivation?
- How do different task types affect search attributes and search strategies?

Improved understanding of how special interest online museum visitors interact with online collections can inform interaction design and contribute to making museum collections both useful and useable.

3. Literature review

3.1. Visitor motivation

Extensive literature examines visitor motivation and behaviour in the physical museum. Lately, the importance of extending the notion of museum visitation to also to cover visits to museum web sites before or after the visit to the physical museum has been stressed (e.g., Kravchyna & Hastings, 2002; Marty, 2008). Research on museum visitor motivation is an important point of departure when aiming to strengthen our understanding of museum visitor information searching behaviour. Visitor motivation and intentionality are elements of the cultural and social context influencing how visitors search and interact with online museum resources.

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In 1998, Booth (1998a,b) reported an extensive study of information needs of both on-site and remote access visitors at the Science Museum in London. Booth (1998a) identified a need for a variety of facilities, including remote access facilities to assist in planning an upcoming visit, to browse galleries and acquire object-related information. Goldman and Schaller's (2004) literature review on the most common motivations from web site visits validates Booth's (1998a) findings and lists the following motivational categories:

- Gathering information for planning an upcoming visit to the physical museum (opening hours, admissions, etc.);
- Self-motivated research for specific content information;
- Assigned research (school or job assignments) for specific content information; and
- Engage in casual browsing.

Recently, a fifth motive, "make a transaction on the website," has been added by Fantoni et al. (2012). Several studies show that planning an upcoming visit to the physical museum is the most frequently mentioned motivation for visiting a museum web site (Booth, 1998a; Goldman & Schaller, 2004; Marty, 2007). However, the present study's target group was, in line with Goldman and Schaller (2004), individuals who look at museum web sites for a content-based reason. This target group was chosen in an attempt to exclude the large number of people planning an upcoming visit. Using Booth's (1998a) terminology, user study participants in the present study were special interest museum visitors pursuing a long-standing interest or hobby (Skov, 2009). From an information-searching perspective, this information-intensive user group is of particular interest.

The concept of meaning making provides an additional approach to understanding museum visitor experience and motivation (Falk & Dierking, 2000; Silverman, 1995; Weil, 2002), stressing the museum visitor's active role in creating meaning from museum objects and exhibitions. Objects displayed in an online exhibition or collection database do not, themselves, represent facts nor do they have any fixed or inherent meaning. Therefore, online, museum visitors' interaction with and understanding of a museum object relies on the individual. Meaning making, or the process by which those objects acquire meaning for individual members of the public, will in each case "involve the specific memories, expertise, viewpoint, assumptions and connections that the particular brings" (Weil, 2002, p. 212). Silverman (1995) further adds to an understanding of meaning-making in the context of a museum experience by stating that "visitors 'make meaning' through a constant process of remembering and connecting.... In museums, people attempt to place what they encounter – be it text, object, fact, perspective – within the context of their experience" (p. 162). The concept of meaning making was explored in an online museum context (Goldman & Schaller, 2004). However, the results regarding meaning making remained too diverse to provide useful correlations, suggesting that other data collection methods than questionnaire surveys are needed.

3.2. Related studies of museum visitors' web search behaviour

Understanding online museum visitor behaviour is critical to the development of relevant and useful museum web sites. Until now, studies of how online visitors search and interact with digital museum resources remain few and scattered. A notable exception is the work by Marty (2007, 2008, 2011), who, in a series of surveys, explored aspects of visitor behaviour with the aim to help museum professionals better understand how new information technologies have changed the way museum visitors approach museums and their resources. Based on a questionnaire survey, Marty explored the museum website in the life of the visitor and showed how "online museum visitors have specific, and different, needs and expectations of museum websites before and after museum visits" (Marty, 2007, p. 356). Marty's (2007, 2008) study further indicates a positive correlation between online and in-person visits, supporting the theory that virtual museums encourage

physical museum visitation, which is also pointed to in related studies (Fantoni et al., 2012; Goldman & Schaller, 2004; Kravchyna & Hastings, 2002). In a later survey, Marty (2011) found users of personal digital museum collection systems to be object focused and motivated by a desire to create lists of objects and images online. A similar object-centred perspective was found in Kravchyna and Hastings (2002). Taking an information-seeking point of view, they found that 63% of online visitors would like to go beyond marketing information and search museum collection databases. In continuation, the authors stressed the importance of providing end users with historical context information as a frame of reference to understand individual museum objects.

Previous research on access to museum websites has improved our knowledge of user demographics, motivation, and expectations of visits, providing a better understanding of how to support different user needs. Additionally, there are more technical aspects of creating access to digitized museum collections using emerging technologies (Styliani, Fotis, Kostas, & Petros, 2009); however, they are not included here as they do not take a user perspective. The review of related studies shows that questionnaire surveys are the predominant data collection method applied. While questionnaire surveys have proven useful to describe *why* online museum collections are used and by *whom*, they have limitations of low response rates (Goldman & Schaller, 2004; Marty, 2007, 2008) and low explanatory power as to *how* users interact with rich museum content such as collection-related information.

4. Methodology

The research design was directed by two primary concerns: the involvement of real users and systems in real-life situations; and relating findings of information searching behaviour to system design and representation of museum artefacts. Both aspects are grounded in Ingwersen and Järvelin's (2005) integrated framework for information seeking and retrieval, which served as the theoretical frame for the study.

4.1. The Military Museum

The case study was carried out in the context of the National Museum of Military History (the Military Museum) in Copenhagen, Denmark. The Military Museum is a museum of cultural history, covering the history of the Danish defence and development of weapons from the introduction of firearms to the present day. The heterogeneous collections of approximately 200,000 museum objects cover a variety of media. As part of the Military Museum's digitisation strategy, online access is provided to a part of the collections on their website (www.thm-online.dk). At the time of this study the collection database covered a unique sub-collection of 1,705 museum artefacts illustrating the development of primarily hand weapons. The collection database can be accessed by browsing through historical eras or doing an analytical facet search. A record including a textual description, metadata, and digital images represents each museum artefact. In addition, high-resolution digital images of original registration materials are attached to each record (see Fig. 1).

4.2. Web questionnaire survey

The web questionnaire survey served two purposes. First, it provided initial information about online museum visitors' areas of interests, purposes of visiting the museum Website, and preferred data elements, as well as demographic data. Second, it recruited participants to the succeeding user study. The questionnaire was published on the Military Museum's Web site and, in addition, advertised in a relevant newsgroup and a printed journal. The questionnaire consisted of closed, pre-coded questions in combination with a few open-ended questions. The online questionnaire was administered over two months from February 2008

The screenshot shows the website for the Statens Forsvarshistoriske Museum. The main content area is titled 'Flintepistol af D. Moore' and features a large, zoomable image of the pistol (C). To the right of the image is a list of metadata (B) including the museum number (29-01679), the type of object (flint pistol), the production date (1790), and the period of use (1790-1850). Below the main image is a grid of smaller images (D) including a photo (A) and high-resolution registration materials. The page also includes a navigation menu on the left and a footer with contact information.

Note:

- A = Textual description of museum artefact
- B = Metadata
- C = Digital image (zoomable)
- D = High resolution digital images of original registration materials

Fig. 1. Example record from the Military Museum's collection database.

to April 2008. A total of 153 respondents completed the questionnaire. This study focused on the 132 respondents who visited the Military Museum's website in connection with their hobby or leisure interest area. The remaining 21 surveys were discarded, as respondents visited the Web site in a study, school, or work context and were thus not regarded as part of the target population. Respondents were aged between 16 and 72 with an average age of 46 and a median age of 45 years. Only two respondents were women, which was not surprising given the coverage of the museum. The majority of the respondents had either "some experience" or were "highly experienced" in relation to their hobby or interest area (see Table 1).

The response rate was difficult to calculate, as it was tricky to determine the size of the target population. However, an estimation of response rate was calculated based on visitor numbers from Google analytics software. According to Google analytics, 1897 unique visitors

visited the Military Museum's collection database during the two-month period, resulting in an estimated response rate of 8%. This is a quite low response rate, which is an often-discussed disadvantage of Web surveys (Zhang, 2000, p. 59). Further, the use of online questionnaires with a self-selected sample has limitations due to difficulties in obtaining a random sample and, accordingly, the present study does

Table 1
Survey respondents' knowledge level (N = 132).

Knowledge level in relation to hobby or interest area	#	%
I have some experience and background knowledge	76	57.6
I'm highly experienced and have extensive background knowledge	40	30.3
I'm a novice with little knowledge within this area	14	10.6
I don't know	2	1.5

not claim representativeness. A self-selected sample method was chosen as it was seen as the only possible way to reach the group of elusive online museum visitors. This is especially the case in the present study, as it aimed to go beyond web survey as data the collection method.

4.3. User study of interactive searching behaviour

The web questionnaire survey was followed by a user study in order to explore how online museum visitors search and interact with the museum collection database. Twenty-four participants were recruited through the web questionnaire. All subjects were men, aged between 32 and 72 with an average age of 49. The majority (20) of the user study sessions took place in an office at the Military Museum's administration building, two sessions took place in participants' private homes, and the last two were conducted at participants' places of work. Building on [Borlund's \(2000\)](#) evaluation framework for interactive information retrieval systems, search tests based on simulated search task situations were conducted. Four simulated search tasks were designed, inspired by real life information needs reflected in written enquiries from the public to the museum. They are described below and the full wording of task A is shown in [Fig. 2](#):

- Task A reflects a well-defined topical information need: Participants were asked to decide on the use of a purchased powder horn based on an enclosed photograph of the "purchased" powder horn.
- Task B reflects a data element search: Participants were asked to identify names of gun makers from the town of Odense and information on their weapons.
- Task C reflects an ill-defined topical information need, a broad and semantically open task: Participants were asked to find information related to the Second World War.
- Task D reflects a combined known item and data element search task: Participants were specifically asked to find information on a Colt Navy revolver seen in the museum's exhibition (known item) and to verify whether the museum has more Colt Navy revolvers (known data element).

In line with other studies using simulated search task situations ([Borlund, 2000](#); [Tombros, Ruthven, & Jose, 2005](#)), participants were instructed to retrieve as many useful documents as it would take to satisfy their information need. In total, 96 search tasks were concluded. During the search sessions, desktop activities including mouse movements were recorded using the Morae software tool version 2.0. A retrospective talk-aloud session took place immediately after a participant completed the simulated search session. Validity of retrospective talk-aloud protocols depends much on the stimuli participants get to help them recall their thoughts ([Van den Haak, de Jong, & Schellens, 2003](#)). Therefore, participants were exposed to a recording of the search process they went through, as recommended by [Van den Haak et al. \(2003\)](#) and [Ingwersen \(1982\)](#). During the retrospective talk-aloud sessions, participants were asked to comment and explain on their search sessions in order to obtain verbalised, explanatory information on the search process. The recorded video clips were subsequently

examined and information was extracted in relation to search attributes. The comparison of various search attributes aimed to verify how different task types affect search attributes and search strategies. A one-way ANOVA test (level of significance of 0.05) was carried out according to the following overall hypotheses in order to analyse differences among the four search tasks in relation to the above listed search attributes:

Ho. no difference exists between the different types of search tasks

Ha. difference exists between the different types of search tasks

A post hoc multiple comparisons test (the LSD test) was used to examine patterns of differences. Like the web questionnaire, recruitment of participants to the user study was also based on a self-selected sample. Therefore statistics were applied in order to explore the quantitative data and support the qualitative data analysis. User study participants' verbal comments during the retrospective talk-aloud sessions, together with observation notes from the search sessions, were analysed using the ATLAS.ti qualitative data analysis software. A coding scheme was developed with the research questions as a starting point. The text material was coded by the first author based on an inductive content analysis.

5. Findings

5.1. Visitor motivation

The first step to characterise information searching behaviour of online museum visitors addressed what initiates online museum visitors' search for information. [Table 2](#) shows survey respondents' purposes for visiting the Military Museum's collection database. Respondents were allowed to indicate more than one purpose of visit. On average, each respondent indicated 2.7 purposes for an online museum visit. The answers indicate the two most frequent purposes were to find "information on a specific type of museum object" and "a photograph or illustration." Less common were broader, topical related purposes like "general knowledge on defence history" and "knowledge on the museums collections."

In continuation of the question of purpose of visit, respondents in the web survey were asked whether they found what they were looking for on the Military Museum's website. [Table 3](#) shows that 29.5% of the respondents were *not* looking for anything specific. This is an interesting finding indicating an exploratory searching behaviour. It supports that leisure tasks and derived information needs of online museum visitors are not necessarily initiated by a problem but, rather, driven by interest. Together, [Tables 2 and 3](#) show the variety of enquiries and reveal that the majority of information needs related to specific types of objects; whereas topical information needs and visits related to broader-level knowledge on defence and military history in general were less frequent. Further, [Tables 2 and 3](#) show that the majority of information needs were specific (e.g., specific type of museum object, photo, or illustration; or specific museum object) and that the majority of respondents found or partially found what they were looking for.

Task A: Powder horn

You went to the flea market last weekend and by coincidence you found an old powder horn. You bought the powder horn and was told that it had been used in connection with hunting. However, one of your friends is certain it was used in the military. Now you are looking for different types of powder horns to try to decide on its use.

Note: A photograph of the 'purchased' powder horn was shown to the use study participant.

Fig. 2. Simulated search task A.

Table 2
Survey respondents' purposes for visiting the Military Museum's collection database (N = 132).

Purpose of visit to the Military Museum's collection database	#	%
Find information on a specific type of museum object	80	61.5
Find a photograph or illustration	66	50.8
To gain knowledge of the museum's collections	59	45.4
To gain knowledge of defence and military history in general	54	41.5
Find information on a specific museum object	47	36.2
Plan a visit to the museum	28	21.5
Find links and references to literature	18	13.8
Other	7	5.4
I don't know	2	1.5

Respondents emphasized the visual, non-textual aspect of searching behaviour and online museum collections and, accordingly, "photograph of object" was the most-often indicated data element. Almost 90% of respondents said that "photograph of object" was a relevant data element in a searchable record of a museum object. Table 4 shows frequencies for each of the 14 data elements listed in the web questionnaire. Respondents were allowed to indicate more than one answer. In addition to "photograph of object," other factual, object-related information like "production year" and "physical description and measurements of the object," together with information on "when was the object used," were rated relevant data elements. Very few museum studies provide comparable information on the data element level. An exception is Booth's (1998a) study that also found factual information and purpose of object to be key object-based information. In general, respondents in the present study indicated a broad range of data elements and were information-hungry, as each respondent on average indicated 7.3 data elements as relevant. In the context of the present study information-hungry can be defined as how participants are highly eager to search for, browse through, and read object related information. Observations from the search tasks exemplify how participants are interested in a broad range of data elements, are willing to accept high recall, and are willing to spend time deciphering handwritten registration material.

5.2. How task type affects search attributes and search strategy

In order to investigate how different task types affect search attributes and search strategy, the 96 search tasks were coded on six quantitative search attribute dimensions and two search strategy dimensions shown in Table 5. For example, the attributes concerning task A were that on average each participant:

- spent 04:58 minutes to complete the task;
- viewed 29.71 items in the search result list (without opening);
- viewed (opened) 2.04 records;
- viewed 0.71 digital photographs;
- used the zoom function 0.42 times;
- viewed digital images of registration material 0.79 times; and
- made 1.42 search iterations.

Further, the main search strategy applied in task A was free text searching combined with direct browsing (using Marchionini's (1995) terminology) by scanning of search results.

Table 3
Survey respondents' expectations of online visit (N = 132).

Did you find what you were looking for on the Military Museum's Web site?	#	%
I found what I was looking for	52	39.4
I was not looking for anything specific	39	29.5
I found some of what I was looking for	34	25.8
I didn't find what I was looking for	5	3.8
I don't know	2	1.5

Table 4
Preferred data elements in a searchable record of museum objects (N = 132).

What type of information on a museum object is relevant to you?	#	%
<i>Factual, object related information:</i>		
Production year	91	68.9
Physical description and measurements of the object	86	65.2
Type of object	68	51.5
Country of production	68	51.5
<i>Visual:</i>		
Digital photograph of object	118	89.4
<i>Provenience:</i>		
When was the object used	86	65.2
Who owned and/or used the object	65	49.2
In which countries was the object used	65	49.2
<i>Associated historic context information:</i>		
In which historic events was the object used	70	53.0
Historic information on periods or events associated to the object	46	34.8
<i>Other:</i>		
Long prose description of the object	75	56.8
References to further information on the object	73	55.3
Short prose description of the object	38	28.8
Other	15	11.4
I don't know	2	1.5

In order to explore the quantitative data, the differences among the four search tasks in relation to the selected search attributes were analysed by variance analysis (ANOVA) using SPSS. A one-way ANOVA test ($p < 0.05$) was carried out. Results of the ANOVA test show a strong association between task type and number of items viewed in the search result list. The post hoc multiple comparisons test (the LSD test) showed that the number of items viewed in the search result list was significantly lower in task B than the other three tasks. This is not surprising, as task B represented a known data element search and most participants searched for the name of the town "Odense" resulting in a result comprising only 7 items.

A weaker association was found between task type and the following three attributes: average search time, average number of digital images of registration material viewed, and average number of search iterations. First, concerning average search time, participants spent significantly more time on the semantically open and ill-defined search task C than the other three tasks. Even though participants spent a longer time on this task, they did not open significantly more records than in the other tasks. Task C is a good example of how participants heavily browsed the search result lists and used the thumbnail images of photographs to assist them in gaining an overview of the results. For example, participant J spent 8 1/2 minutes on task C and opened only a single record. The results indicate an association between task and average search time: more time is spent on semantically open topical search tasks.

Second, on average, less registration material was viewed during search task A (powder horn) than in the other tasks. The digital image of original registration material contains additional information on physical object description, provenience, etc. However, the answer to task A can be found without consulting the registration material, which explains the low number of average material viewed in this task. Third, participants made fewer search iterations in task C and D than in task A and B. As explained below, the main search strategy applied in task C was browsing and, hence, a low number of search iterations were to be expected in this task. In task D most participants applied a single search term resulting in few search iterations. Overall, the findings correspond to previous results concerning end-user searching: end-user searchers still make simple, short queries with few free-text search terms and little use of advanced features (Markey, 2007). The statistical tests showed no patterns of differences concerning task types and the following three attributes: number of records viewed, number of digital photographs viewed, and number of times zoom function used. Consequently, the null-hypothesis concerning these three attributes cannot be rejected.

Table 5
How type of search task affects search attributes and search strategy (n = 24).

Search attributes of simulated search tasks:	Task A Powder horn	Task B Gun makers	Task C 2 nd WW	Task D Colt
Average search time (minutes)	04:58	05:07	07:31	05:31
Items viewed in the search result list (average)	29.71	10.29	28.88	29.54
Museum records viewed (average)	2.04	3.58	2.88	2.33
Digital photographs viewed (average)	0.71	0.38	1.25	0.83
Use of zoom function (average)	0.42	0.17	0.54	0.25
Digital images of registration material viewed (average)	0.79	2.21	1.75	1.63
Search iterations (average)	1.42	1.38	0.58	0.79
Search strategy:				
Main search strategy applied:	Free text searching	Free text searching	Browse historical periods	Free text searching
Type of browsing:	Directed browsing of search results	Directed browsing of search results	Semi-directed browsing	Directed browsing of search results

A clear association was found between search strategy and type of information need. In the three simulated search tasks representing well-defined information needs (tasks A, B, and D) the main search strategy applied was free text searching. Especially in task D (Colt Navy) free text searching was combined with use of the drop-down menus to limit the query by “country of production” or “object type.” In these three tasks participants also used a *directed browsing* strategy. Directed browsing, as characterised by Marchionini (1995), was conducted in the form of scanning the result lists to compare well-defined sets of objects. In the semantically open and ill-defined task C, on the other hand, the main search strategy applied was browsing of historical eras to explore the Military Museum’s collections related to the Second World War. Compared with the other three tasks, participants applied a less systematic, semi-directed browsing when examining records. However, instead of browsing, five participants (B, K, L, R, and S) chose to apply rather specific, free-text queries in task C (e.g., a search on the “Madsen machine gun” related to the Second World War). Ingwersen and Järvelin (2005, p. 293) explain how searchers may very well seek known items –avoiding topical searching – feeling the former to be easier. Hence, a known item search function as a starting point for finding “something topically similar or content-like” with respect to the found item. The example shows how transition between the different information need types is continuous.

5.3. Four characteristics of museum visitors’ web search behaviour

Four main characteristics of online museum visitors’ searching behaviour were identified as a result of the inductive content analysis. In the coding process, observations of participants’ searching behaviour during the simulated search tasks sessions were coupled with participants’ explanations and comments related to the search sessions. The coding process identified and grouped aspects of visitor motivation and applied search strategies. In this way, the four characteristics emerged from the authors’ interpretation of the coded data.

5.3.1. A highly visual experience

Participants’ searching behaviour has a strong *visual* aspect, which is confirmed by findings on preferred data elements (see Table 4). The photographs in the collection database were used as browsing, identification, selection, and zooming devices. Thumbnail images of photographs shown in the result lists constituted an important feature which that supported participants when browsing the result lists and choosing which records to view. Participants commented, “It is really nice. The photographs in the result list help you to deselect many items” (Participant S: line 94) and “It is a good thing. Especially when I know something about the items because then I can quickly go through the list and find what I need” (Participant M: line 148).

Thumbnail images in the result list were also used during browsing to gain an overview of the search result. The visual aspect was especially

important in simulated search task A, where a photograph of a “purchased” powder horn was shown to the participants. Comparing this photograph with the thumbnail images helped participants to decide which museum objects resembled the “purchased” item (Participants D, F, I, Q, V and Y).

5.3.2. Exploratory searching behaviour

This subsection addresses characteristics relating to an *exploratory searching behaviour* of online museum visitors, which is predominantly in topical searching. The visual aspects of searching behaviour directly support exploratory behaviour. Different aspects of exploratory searching behaviour were identified across task types. The most significant was *information encountering*, as described by Erdelez (2000) or the strongly related aspect of serendipity (Foster & Ford, 2003). Quotes from participants illustrate how participants recognise the *accidental* encountering of information during browsing or targeted search for some other information; for instance:

You might see a hundred ‘gravkors’ [a type of sword] which all have an often seen mark from, e.g., the 5th or the 7th battalion. But then you see one with an absolutely crazy mark which no one can explain. And that is the fun part of it.... (Participant A: line 164).

Another aspect signifying an exploratory approach to information seeking is how participants choose which records to view. For example, during the semantically open and ill-defined topical search task C (the Second World War), participants were asked how they decided which records to open from the search result list. Their answers can be grouped into two categories: either they pursued a known item to see if the museum records verified information already familiar to them; or participants followed items that somehow differentiated from the other items in the result list or caused surprise. The latter signifies an exploratory approach. Thus, based on observation of the search tasks and participants’ comments from the talk-aloud session, the following three elements were identified to support accidental or serendipitous discoveries:

- Photographs were used to support browsing. Especially useful were photographs that showed the context of the object (e.g., how an object was used or related to other objects).
- References between related objects allowed users to discover new associations.
- The collection database supported both browsing through historical eras and query search entries. Hence, different structures of the information space also supported information encountering.

5.3.3. Broad known item or element searches

In general, participants knew what they were looking for and, due to their long-standing interest in defence and military history, they knew professional jargon. In three out of the four simulated search tasks, the

main search strategy applied was a free text search (see Table 5). Very few and broad search terms were used (e.g., “colt,” instead of “colt navy”) because ambiguous or insufficient object descriptions challenge the search process:

It is interesting to see what information the Museum holds on the G3. . . . Everyone knows that it is the old German MG42 which was changed and bought by the Danish army in 1962. That is why we call it the M62 machine gun. However, correctly it is called MG3 – Maschine Gewehr drei. But no one knows what a MG3 is. But everyone knows the M62.... And what about the production year of the MG3? Is it the production year of the Museum’s item or is it the production year of the model? (Participant I: line 96).

Likewise, due to the sometimes-ambiguous object descriptions, several participants described how they accepted browsing through a long result list to find their known item. In other words, low precision was accepted in order to achieve high recall. This finding supports explorative search behaviour.

5.3.4. Meaning making

The concept of meaning making was introduced in Section 3.1 and different aspects of meaning making were identified. First, the digitization strategy of the Military Museum’s collection database, representing a mix of raw and refined information (Orna & Pettitt, 1998), meant that online museum visitors were *not* directed by the choices and views expressed in carefully designed exhibitions with highly mediated information; instead they were free to (or forced to) navigate and follow their own paths. Consequently, they relied on their background knowledge of defence and military history in order to conclude how objects relate or differentiate, or in order to make implicit features of information explicit, etc. As an example, a participant looked for characteristics that could help differentiate between similar models to form a general view of the objects in the search result:

When I browsed around looking at the different rifle models 1889s, I tried to establish my own leitmotif. How do they differ? How can I be completely sure? How can I tell the differences between them? Yes, here are two important differences and they will help me differentiate later. (Participant L: line 98).

Likewise, a participant used his background knowledge on the Second World War to add to the scarce associated historical context information in the collection database. He tried to establish a link between a specific object and the historical context:

I recognise many of the weapons from what I have read and been told about the Allies’ weapon supplies [to Denmark]. However, I’m puzzled about the Russian machine gun in this context. How did that come all the way to Kolding? Maybe, it could be that... (Participant K: line 197).

The examples show how participants used their previous experience and special knowledge of military history to help them interpret new cues. In this way, they attempt to place what they encounter within the context of their experience as part of a meaning making process.

6. Future research

The present case study focuses on a small museum collection. Future research should encompass a more realistic research design on user interaction with larger cultural heritage collections (e.g., the Europeana portal: www.europeana.eu/portal) providing access to millions of cultural heritage objects. Finally, it is relevant to take an information-seeking perspective on digital museum resources and study information needs, as well as use of information sources and channels, to add to the characteristic of the elusive online museum visitor and, thereby, answer

a recent call (Ellenbogen et al., 2008; Marty, 2008) to explore the use of digital museum resources in the daily lives of museum visitors.

7. Conclusion

The present case study of special interest museum visitors’ interactions with the Military Museum’s collection database adds to understanding of the characteristics of information-searching behaviour in the context of digital museum resources. The methodological approach goes beyond survey questionnaires and focuses on content-based reasons for museum visiting. Accordingly, the results regarding visitor motivation show that the two most frequent purposes were to find “information on a specific type of museum object” and “a photograph or illustration.” The study successfully reached the target population of special interest museum visitors, which was intentionally different from related survey studies (e.g., Marty, 2007, 2008). Results on preferred data elements also relate to visitor motivation and provide information on a more detailed level. First and foremost, the findings stress the strong visual aspect of searching online museum collections. In addition, most metadata elements on factual, object-related information, provenience, and the historic context was indicated relevant by the majority of the respondents, characterising the group of special interest museum visitors as information hungry. The results of the quantitative data on search attribute and search strategy dimensions show that the ill-defined task C, especially, differs from the other three tasks. The latter represent various types of well-defined information needs. In the ill-defined, topical information task, the main search strategy applied was browsing of historical eras combined with semi-directed browsing of result lists. In the other three tasks, the main search strategy was free text searching and direct browsing of search results. The results indicate an association between task and “average search time”: more time is spent on semantically open topical search tasks. Knowledge of preferred data elements and search attributes provides suggestions that can inform planning of museum digitisation efforts.

Four main characteristics of online museum visitors’ searching behaviour were identified: (a) a highly visual experience, (b) exploratory behaviour, (c) broad known item/element search, and (d) meaning making. The first aspect stresses the strong visual aspect of searching virtual museum collections and that photographs are used as scanning, identification, selection, and zooming devices. The simulated search tasks showed how participants used broad search terms and accepted low precision in order to secure high recall. This said, exploratory aspects of searching behaviour were identified across search tasks (e.g., information encountering and serendipitous discoveries). Accordingly, the design of information systems providing access to museum collections should support both known item and exploratory searches. Finally, across tasks, *meaning making* is defined as the fourth main aspect of online museum visitors’ searching behaviour. In the process of meaning making users rely on their specific background knowledge and experiences to navigate and make sense of information found (Weil, 2002). The four characteristics add to our understanding of *how* special interest museum visitors interact with digital museum resources, thus adding to previous studies of visitor motivations explaining *why* they interact.

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References

- Anderson, G. (2004). *Reinventing the museum: Historical and contemporary perspectives on the paradigm shift*. Lanham, MD: Altamira.
- Black, G. (2005). *The engaging museum: Developing museums for visitor involvement*. London, UK: Routledge.

- Booth, B. (1998a). Understanding the information needs of visitors to museums. *Museum Management and Curatorship*, 17(2), 139–157.
- Booth, B. (1998b). Information for visitors to cultural attractions. *Journal of Information Science*, 24(5), 291–303.
- Borlund, P. (2000). Experimental components for the evaluation of interactive information retrieval systems. *Journal of Documentation*, 56, 71–90.
- Ellenbogen, K., Falk, J., & Goldman, K. H. (2008). Understanding the motivations of museum audiences. In P. F. Marty, & K. B. Jones (Eds.), *Museum informatics: People, information, and technology in museums* (pp. 187–194). New York, NY: Routledge.
- Erdelez, S. (2000). Towards understanding information encountering on the web. In D. H. Kraft (Ed.), *Proceedings of the 63rd ASIS Annual Meeting, 12–16 November, 2000, Chicago* (pp. 363–371). Medford, NJ: Information Today.
- Falk, J. H., & Dierking, L. D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek, CA: AltaMira Press.
- Fantoni, S. F., Stein, R., & Bowman, G. (2012). Exploring the relationship between visitor motivation and engagement in online museum audiences. In J. Trant, & D. Bearman (Eds.), *Museums and the Web 2012: Proceedings*. Toronto, Canada: Archives & Museum Informatics.
- Foster, A., & Ford, N. (2003). Serendipity and information seeking: An empirical study. *Journal of Documentation*, 59, 321–340.
- Goldman, K. H., & Schaller, D. (2004). Exploring motivational factors and visitor satisfaction in on-line museum visits. In D. Bearman, & J. Trant (Eds.), *Museums and the Web 2004: Proceedings* (pp. 223–235). Toronto, Canada: Archives & Museum Informatics.
- Ingwersen, P. (1982). Search procedures in a library - analysed from the cognitive point of view. *Journal of Documentation*, 38, 165–191.
- Ingwersen, P., & Järvelin, K. (2005). *The turn: Integration of information seeking and retrieval in context*. Berlin, Germany: Springer.
- Jørgensen, C. (2004). Unlocking the museum: A manifesto. *Journal of the American Society for Information Science and Technology*, 55, 462–464.
- Kravchyna, V., & Hastings, S. (2002). Informational value of museum web sites. *First Monday*, 7(2), <http://dx.doi.org/10.5210/fm.v7i2.929>.
- Marchionini, G. (1995). *Information seeking in electronic environments*. Cambridge, UK: Cambridge University Press.
- Markey, K. (2007). Twenty-five years of end-user searching. Part 1: Research findings. *Journal of the American Society for Information Science and Technology*, 58, 1071–1081.
- Marty, P. F. (2007). Museum websites and museum visitors: Before and after the museum visit. *Museum Management and Curatorship*, 22(4), 337–360.
- Marty, P. F. (2008). Museum websites and museum visitors: Digital museum resources and their use. *Museum Management and Curatorship*, 23(1), 81–99.
- Marty, P. F. (2011). My lost museum: User expectations and motivations for creating personal digital collections on museum websites. *Library & Information Science Research*, 33, 211–219.
- Orna, E., & Pettitt, C. W. (1998). *Information management in museums*. Aldershot, UK: Gower.
- Semper, R. (1998). Designing hybrid environments: Integrating media into exhibition space. In S. Thomas, & A. Mintz (Eds.), *The virtual and the real: Media in the museum* (pp. 119–127). Washington, DC: American Association of Museums.
- Silverman, L. H. (1995). Visitor meaning-making in museums for a new age. *Curator*, 38(3), 161–170.
- Skov, M. (2009). *The reinvented museum: Exploring information seeking behaviour in a digital museum context* (Unpublished doctoral dissertation). Copenhagen, Denmark: Royal School of Library and Information Science. Retrieved from <http://pure.iva.dk/files/30768221/MetteSkovThesis.pdf>
- Styliani, S., Fotis, L., Kostas, K., & Petros, P. (2009). Virtual museums, a survey and some issues for consideration. *Journal of Cultural Heritage*, 10, 520–528.
- Tombros, A., Ruthven, I., & Jose, J. M. (2005). How users assess web pages for information seeking. *Journal of the American Society for Information Science and Technology*, 56, 327–344.
- Van den Haak, M. J., de Jong, M. D. T., & Schellens, P. J. (2003). Retrospective vs. concurrent think-aloud protocols: Testing the usability of an online library catalogue. *Behaviour & Information Technology*, 22(5), 339–351.
- Weil, S. E. (2002). *Making museums matter*. Washington, DC: Smithsonian Institution Press.
- Zhang, Y. (2000). Using the internet for survey research: A case study. *Journal of the American Society for Information Science*, 51, 57–68.

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