Information on the Go: A Case Study of Europeana Mobile Users

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According to estimates the mobile device will soon be the main platform for searching the web, and yet our knowledge of how mobile consumers use information, and how that differs from desktops/laptops users, is imperfect. The paper sets out to correct this through an analysis of the logs of a major cultural website, Europeana. The behavior of nearly 70,000 mobile users was examined over a period of more than a year and compared with that for PC users of the same site and for the same period. The analyses conducted include: size and growth of use, time patterns of use; geographical location of users, digital collections used; comparative information-seeking behavior using dashboard metrics, clustering of users according to their information seeking, and user satisfaction. The main findings were that mobile users were the fastest-growing group and will rise rapidly to a million by December 2012 and that their visits were very different in the aggregate from those arising from fixed platforms. Mobile visits could be described as being information "lite": typically shorter, less interactive, and less content viewed per visit. Use took a social rather than office pattern, with mobile use peaking at nights and weekends. The variation between different mobile devices was large, with information seeking on the iPad similar to that for PCs and laptops and that for smartphones very different indeed. The research further confirms that information-seeking behavior is platform-specific and the latest platforms are changing it all again. Websites will have to adapt.

Introduction

A new information revolution is rapidly unfolding: the ubiquitous mobile phone is now being used more for retrieving information than talking, and by 2013 it is forecast that mobile phones will overtake PCs as the most common web-access device (Gartner, 2011). However, most websites have been designed for PCs and laptops; and clearly accessing the web via a mobile device, possibly, on the move, is quite a different experience to accessing the web from a PC or laptop in an office. And, of course, the environment in which they are used could not be more different from that provided by the traditional library, for which many scholarly websites were conceived. Mobile devices will, undoubtedly, also draw in a bigger (there are more of them) and, just possibly, a different audience (more digital natives, perhaps) for scholarly and cultural web providers. So we might expect that information, usage, and reading behavior will differ from that associated with desktops and laptops. This paper sets out to determine whether indeed this is the case. We believe it to be one of the largest and most comprehensive studies of its kind.

The study investigated information behaviors with regard to a major European multilingual and multimedia cultural website, Europeana (www.europeana.eu). Europeana, launched in November 2008, is a gateway, portal, or search engine to the digital resources of Europe's museums, libraries, archives, and audiovisual collections. More than 15 million cultural objects—images, texts, sounds, and videos—from 27 European countries can be accessed via the website. It is essentially a shop window for other people's content and a channel for digital content distribution and as
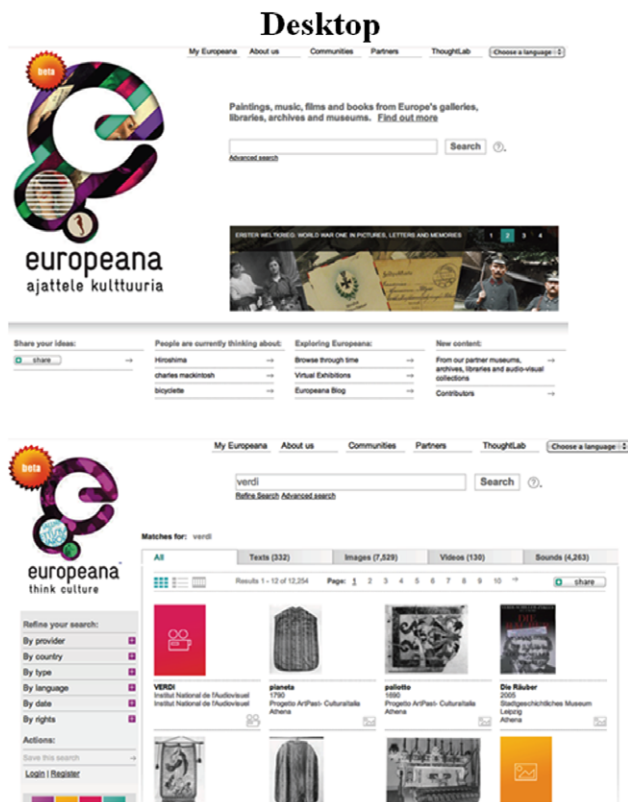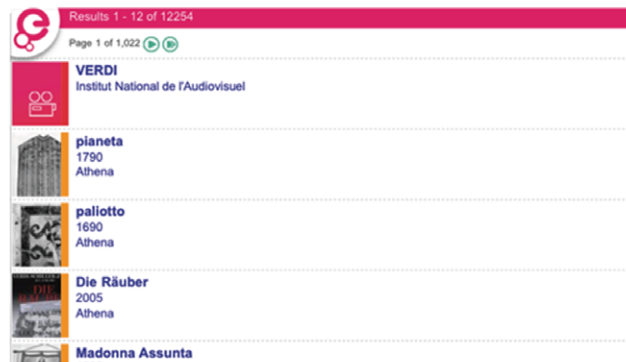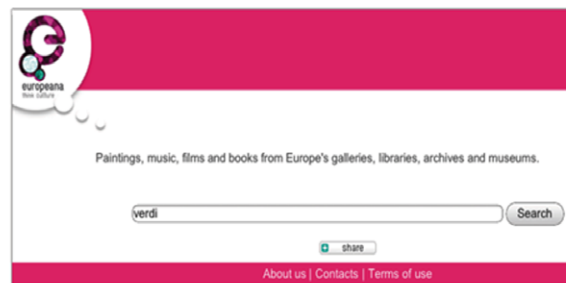
FIG. 1. Screenshot of Europeana (homepage, above; search results, below). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

such it should not be used or judged as a content-rich site. However, Europeana is a particularly insightful case for a study of information seeking and use on the move for it should appeal to a very large and economically important community that is always on the move—tourists. Figure 1 shows the interface of Europeana for mobile and desktop.

Europeana from the beginning was prescient in its design of a "lite" interface for users with mobile phones, but the recent explosion in tablet devices, such as iPads, is presenting new challenges.* Research was commissioned to identify the challenges and opportunities and is reported here. The mobile research reported here is in fact a part of a much bigger study, Europeana Connect, in which the authors are engaged and this covers all types of users on all platforms. That enables us to compare mobile users with other groups of users. Again, for full details, see the CIBER website (CIBER, 2011).

Specific Aims and Objectives

With regard to Europeana:

1. Determine the popularity of mobile use, plot growth, and forecast future levels of growth;

2. Define the characteristics of use and information-seeking behavior of mobile users;
3. Establish the differences between types (e.g., smartphones, tablets) and brands (e.g., iPad, Blackberry) of mobile devices in terms of number of users, use, and information-seeking behavior;
4. Establish whether mobile use and information seeking behaviors are different from those associated with traditional PC and laptop users; whether it leads to different outcomes and levels of success;
5. Seek explanations for the differences between the performance of platforms and devices;
6. Demonstrate the utility of employing "footprint", deep log techniques for platform comparison purposes.

Research Context

Early studies, such as that of Sellen, Murphy, and Shaw (2002), show that, not unexpectedly, mobile users avoided complicated tasks such as information gathering and would postpone them until they had access to a conventional computer. This was because of usability issues, as it was not easy to open multiple browsers and type long pieces of text. Jones, Buchanan, Cheng, and Jain (2006) made the obvious, but very important, point that before internet-enabled hand-held mobile devices became ubiquitous, people could not fulfill the information needs that arose when they were away from their office or home. But with a mobile device information needs, in theory, can be fulfilled anywhere and anytime. That is why mobiles have found their way into

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*It is forecast that Apple will have sold more than 100 million iPads by the end of 2012. http://www.washingtonpost.com/business/technology/ apples-record-ipad-sales-in-context/2012/03/20/gIQAaxDYPS_story.html

people's work-related information seeking, and especially so in the medical field, where practitioners are away from the office (Axelson, Wårdh, Strender, & Nilsson, 2007).

Burdette, Herchline, and Oehler (2008) maintained that little to nothing has been written on how the advent of the smartphone has affected users' behaviors and needs. Since then, however, a number of studies have been published, albeit rather small scale and narrow in scope. A mixed method study of information-seeking behavior on mobiles identified three categories of behavior (in popularity order): 1) fact finding: seeking specific information; 2) casual browsing: accessing general information, without a specific goal other than being entertained or updated; 3) gathering information from multiple sources to achieve a broad goal, such as making a decision, or to collect knowledge around a topic (Cui & Roto, 2008).

A number of diary and interview studies have been undertaken on mobile users' information behavior, especially with regard to what is being sought. Most confirm that while a significant number of queries are found to be context-free, i.e., fact finding (Hinze, Chang, & Nichols, 2010), changing contexts such as location, time, activity, and social interactions are likely to impact on the types of information needs that arise (Church & Smyth, 2009). For example, a log study by Halvey, Keane, and Smyth (2006) showed that accesses to particular categories of pages via mobile phones vary relative to time (weekend and leisure time vs. weekdays and work time). Frequent query topics that arise in studies (such as those of Dearman, Kellar, & Truong, 2008; Amin, Townsend, Ossenbruggen, & Hardman, 2009; Church & Smyth, 2009) include: news, travel and transport, entertainment, trivia, shopping, and food and drink. However, interestingly, log analysis studies that have been conducted (Kamvar & Baluja, 2007; Yi, Maghoul, & Pedersen, 2008), showed "adult" searches were very popular, something that diary and interview studies did not reveal.

Church and Smyth (2009) in a diary study found much difference between information needs associated with a mobile search and those associated with a desktop search. They attributed this difference to the fact that mobile users were on the move and as such were interested in locating different types of content, for instance, connected with moving around (e.g., maps, shops, restaurants, local services, commuting, and transport).

There have been quite a few log studies but most concern themselves with general search engines and queries. The most relevant findings from this body of literature (Yi & Maghoul, 2011; Kamvar, Kellar, Patel, & Xu, 2009; Yi, Maghoul, & Pedersen, 2008; Church, Smyth, Cotter, & Bradley, 2007; Church, Smyth, Bradley, & Cotter, 2008) in the context of this paper are that the mean term count for queries is between 2.1 and 2.7 and the character count between 13 and 15.

It appears that nobody has compared the use of the same website by mobile and desktop users. The closest we can get to this is to compare individual studies on the respective platforms, but published at different times. Such comparisons are clearly problematic but if we take, for instance, studies of Google mobile logs by Kamvar and Baluja (2006, 2007) and compare them with desktop log research by Jansen, Booth, and Spink (2009), it appears that desktop users enter slightly more words per query and queries per session, and their queries are much more diverse. There were some differences between smartphone users and PDA users in terms of their search behavior. For example, their queries were a little longer and they searched less for adult content. Researchers speculated that this might be because PDA has a better keypad for text entry and PDA users might belong to a different social class (business people), hence the difference in their content searches.

Most recently, a study of mobile spoken queries by Kamvar and Beeferman (2010) showed that, contrary to intuition, longer queries had a higher probability of being typed than shorter queries. However, another, even more recent, study (Yi & Maghoul, 2011) contradicted these findings (3.41, 2.23, and 2.78 words, for voice, typed mobile, and PC search queries, respectively). The study also showed that, using voice interface, users tend to pose queries in natural language with many function words: "starbucks in chicago" vs. "starbucks chicago."

The review of the literature reveals that, although studies have been conducted on surfing and searching the web using mobile phones, none has covered the cultural or digital humanities field nor does any cover more than a couple of months' data and, perhaps, most important of all, most of them were conducted before the widespread adoption of the iPad.

Methodology and Dataset

Log analysis techniques were used to analyze log files of users' interactions with the Europeana website. Everyone who uses the website leaves a record of their movements on the particular platform they used, be that a mobile phone, laptop, or iPad. Using log analysis, we studied how people actually seek, search, navigate, use, and act upon information in the virtual space. Log analysis has been used typically for the analysis of search engine queries (e.g., Spink & Jansen, 2004; Jansen & Spink, 2006) and manuals now exist for detailing the techniques (Jansen, 2006; Jansen & Spink, 2009). When log analysis is used to provide very detailed, bespoke user-oriented analyses of digital services and sites, we call it "deep" log analysis to distinguish it from "flat" log analyses of the kind produced by researchers using Google Analytics (GA), which tends to be used for marketing purposes. The log files included the usual log fields such as date, time, IP, referrer, and user-agent and we used SPSS (Chicago, IL) for the analysis. More information can be found in Nicholas and Clark (2012) regarding the method.

The data analyzed included 2 years of standard log files (October 2009 to October 2011). In all, the dataset contained 150 million page views made by 4.5 million unique visitors. The time windows for the analyses vary. Background, contextual, and historical all-platform growth data are generally

provided from the date of the first Europeana logs (October 2009). Analyses that are more sensitive to the recent introduction and rapid growth of the mobile market are provided for a shorter and more recent period, generally, September 2010 to August 2011 or December 2010/January 2011 to July/October 2011.

Working Definitions of Key Terms, Metrics, and User Categories Employed

Users: were defined by a combination of internet address and user agent string. Although not formally a unique identifier, in practice this proves sufficient to distinguish one personal user from another. User and robot distinction can be achieved through logged user-agent information. Human users were divided into mobile users (people accessing Europeana by smartphones and tablets and easily identified through the user-agent string in the logs) and, for want of a better term, "fixed" users (people accessing by desktop or laptop PCs). Clearly this is only a working categorization and not a completely watertight classification because some people will have used their laptops on the go, but on the whole laptops owe more to the desktop than to the phone. In the future (the research is in still progress) we shall develop a more reliable and relevant classification to distinguish both format constraints (phone vs. pad) and mobility (roaming vs. tethered). We should also say that the iPad did not exist when we started the research, and "smartphones" were not significant enough to constitute a separate category. There were phones that clearly needed a different webpage to accommodate a small screen and presumed limited data transfer. The iPhone was merely a significant part of a small but growing market segment. When the iPad was introduced it created a new category, but that was only apparent post facto. What was obvious and detectable was a user-agent and thus a rendering engine that behaves very much like an iPhone with a big screen. It is thus an historical artifact that we classified all these as "Mobile." This ontology was also implicit in the functioning of the earlier versions of the site: all "mobiles" were served as a simplified page designed for small screens with low pixel densities. The site was revised in 2011 to recognize the new reality: that anyone using a site such as Europeana will be viewing on a screen with a significant number of pixels.

Page views: the primary measurement of use. A page view is a new display that results from clicking on a link or typing in a web address. By a new display we mean the refreshing of a complete page: thus, changes to the display such as pop-ups on mouse-over or the suggestions displayed when typing in a search box are not considered a new page.

Queries: refers to search strings, searches per visit, and is a metric that points to level of engagement.

Visits (or sessions): another use measurement that constitutes a sequence of page views that we can ascribe to one user, at one location, with an implicit continuity from first page to last. Although the Europeana.eu site uses session cookies, these are not recorded in the log files, hence our visits are defined independently of the sessions defined by cookies. This provides some flexibility in the post facto definition of a visit. We are thus not constrained by the conventions of advertiser-driven analytics; our visits seek to capture an Aristotelian unity of action, time, and place. That is, a visit has one actor, begins with a referral from another site, follows a chain of links from one Europeana page to another, and lasts no longer than 1 day.

Time: two time metrics can be used to estimate use, visit, and page-view time. Traditionally time metrics, of whatever type, are used to show site "stickiness" as a surrogate for interest and satisfaction, the supposition being the longer the better. Even in the case of major publisher platforms, it is questionable whether these metrics do demonstrate interest and satisfaction. In the case of a gateway, portal, or search-centric site like Europeana the opposite could be argued: the faster people move through the site the better and the more efficient the indexing and navigation.

Limitations of Log Analysis

It should be said that although log analysis can answer many questions (such as how much, how long, how many, and other "how" questions) about users' information seeking, it leaves many questions (such as why questions) unanswered, questions that should be answered using methods such as questionnaire surveys and interviews.

Results

In this section we first present general all-platform data for scene-setting purposes and then a detailed evaluation of the users, use, and information-seeking behavior of mobile (tablets and smartphones) users, together with comparative data for PC/laptop users.

Categories of Users

While this paper focuses on users defined by the particular platform (mobile devices) used to access Europeana, they constituted only a minority of the population covered by the research project from which the data are drawn. As mentioned earlier, the project itself, part of Europeana Connect, covered all users, irrespective of the platform used. This of course enabled us to view the behavior of mobile users in context, something which adds considerably to our understanding of the information-seeking behavior of this group. Indeed, that is really the only way to find out, head-to-head, whether mobile behavior is special or unique. Thus, for the broader Europeana Connect study we identified three classes of "real user" or nonrobotic user: "one shots," heavy users, and normal users. One-shot users are those people who viewed one page in one visit and who have not returned to Europeana during the 2-year study period. Heavy users are genuine users who have over the past 2 years each viewed thousands of Europeana pages. In many cases this activity is based on institutions associated with the Europeana project:

it will include both development activity from within and general use from public kiosks. Group use by schools and colleges is another common heavy user case. The criteria used to identify heavy users are relative and continually reviewed as the data accumulates. At the time of writing, heavy users were classified as being those who over the 2 years viewed 1,900 pages or 1,100 pages in 1 month. The objective was to select the heaviest users and set the lower bound at a level that captures the majority of internal (Europeana) and significant instances of institutional use (museums, libraries, etc.). One-shot and heavy users, in their different ways, are significant and strategic user groups (one shots because of their transience, and heavy because they represent a core group); we need to know them better, and by applying a "top and tail" filter to the user category, setting them aside for special study, this way we also clarify the middle ground: the millions of run-of-the-mill Europeana users, who can be dubbed "normal users."

Mobile users, the focus of this paper, are easily identifiable because their operating systems are recorded in the logs. As the numbers are relatively small and the localization of internet address less reliable, we have not topped and tailed this category as we did for fixed users. For some analyses we subdivided the category into "phones and pads" and by individual brand, but with numbers small and the trend volatile we need to be aware of over-fine categorizations.

In the 12 months, September 2010 to August 2011, Europeana had around three million unique visitors. There were 1.2 million one-shot users, accounting for 41% of all visitors. The "heavy user" category, where many users may share an institutional connection, consisted of 18,000 users, representing 0.7% of all users, but they, of course, accounted for a far higher proportion of visits and page views. There were 1.7 million "normal" users, and they accounted for 56% of all users. As for mobile users, they numbered 69,000 (2.3% of all users). While mobile users were relatively small in number, they were in fact the fastest-growing category of Europeana users. Over the 12 months from August 2010 to July 2011, page views from mobile devices grew at a rate four times greater than from fixed devices and we forecast that they will number just shy of one million (977,000) visitors and comprise around 17.6% of visitors by December 2012. Enhancements to the mobile Europeana experience, which are currently under way as a result of the findings of our research, could change this proportion considerably upwards, especially since it is likely that the installed base of internet-ready mobile devices will actually overtake that of desktops and laptops around 2013 (Gartner, 2011).

Mobile devices do differ in size, shape, design, and performance and there is clearly quite a big difference between smartphones and iPads or tablets, which are the size of small laptops and have excellent screen resolution. However, both use the same operating system and are served with the same "lite" interface by Europeana, a cascading style sheet intended for small-screen, restricted-data bandwidth mobile phones. Therefore, it is important to analyze the log data at
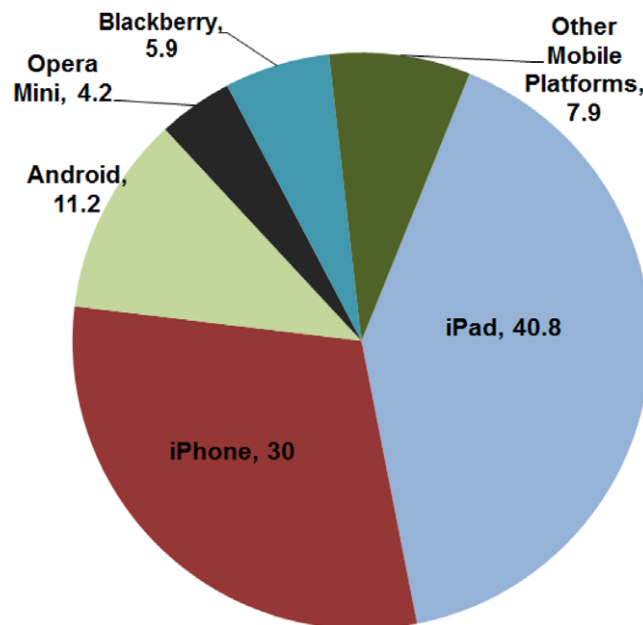

FIG. 2. Total mobile page views by brand, January to July 2011. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

the individual mobile device and brand level to establish differences in use and performance.

Figure 2 shows that Europeana's mobile users prefer the Apple brand, with traffic dominated by its iPad and the iPhone which, in July 2011, accounted for more than 70% of all mobile page views. These devices are particularly suited to viewing cultural content because of their very high definition, and the young affluent and highly educated demographic for these products also sits well with Europeana's high-minded cultural ideals. The Android platform accounted for 11.2% of page views and Blackberry 5.9%.

Figure 3 provides historical growth data for mobile usage generally as well as a breakdown for each brand. The monthly page views numbers show an exceptionally rapid period of growth following search engine optimization (SEO) in December 2011. SEO changed the way the site is used: new users now go direct from search engine to content (record page) rather than to the home page. Not surprisingly, perhaps, the iPad is shown to be the main driver of mobile growth. The surge in use in April can be attributed to seasonal use of Europeana by French schoolchildren using it as part of a national classroom exercise. By way of explanation, Europeana is held in high esteem by the French government, who view it as an important shop window for French culture.

Time Patterns of Use

Unsurprisingly, the volume of activity on Europeana, as expressed by page views, varies considerably between the week and the weekend and times of the day as people shift between different contexts, locations, and personas. Mobile use follows a different rhythm, a more social (rather than
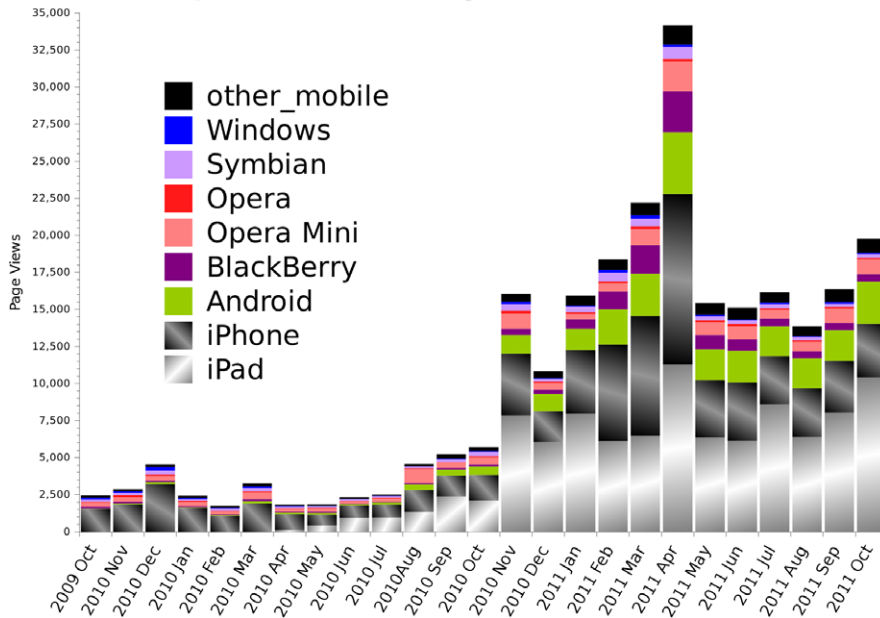
Europeana: Mobile PageViews 2009–2011

FIG. 3.   Monthly page views by mobile platform. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]
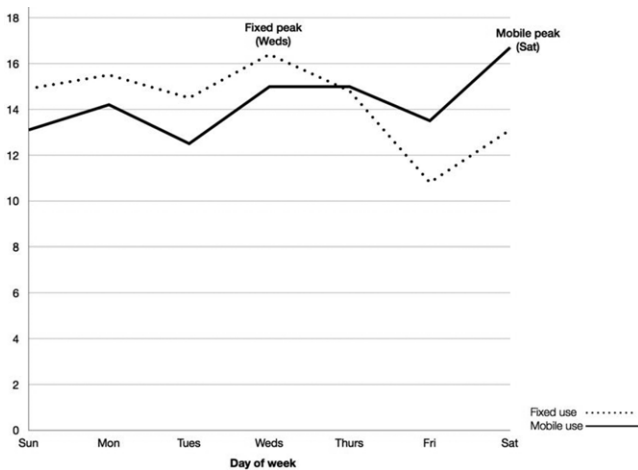

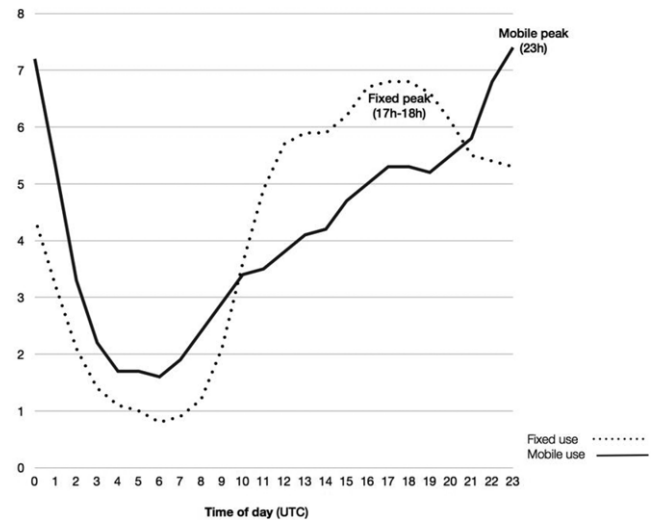FIG. 4.   Percentage of page views within category: mobile and fixed users by day of week.

FIG. 5.   Percentage of page views within category: mobile and fixed users by time of day.

traditional work) one. Thus, mobile use typically peaks late into the night and on Saturdays, whereas fixed use peaks in the early evening and on Wednesdays (see Figures 4 and 5, data for October 2010 to July 2011). Mobile devices have considerably widened access to Europeana on weekends and outside of traditional office hours. More research is needed to determine whether this use is different qualitatively as well as quantitatively: do, for instance, users express different personas at these times?

Geographical Location of Users

Although Europeana provides access to cultural artifacts of European countries, about a third of all mobile visitors

came from outside the EU. Of the EU countries, France has, by far, the lion's share of the mobile market for Europeana content, with just under a quarter (23.6%) for the period October 2010 to July 2011, and despite having the second lowest number of mobile subscriptions per 100 inhabitants within the EU (European Interactive Advertisers' Association, 2011). This is partly explained by the fact that French content looms large in Europeana (France is the third biggest content provider) and, as we have just learned, Europeana is widely promoted in French schools, something that also explains the high levels of fixed use. Within the EU France

is followed by the UK (10.9%), Germany (8.0%), and the Netherlands (6.4%). Germany is in fact the biggest contributor of content to Europeana, so it gives more than it takes, and the Netherlands performance is explained by the fact it is where Europeana is based, so will inevitably punch more than its weight. The performance of Italy, a country with a large population and very rich cultural heritage, is probably a surprise, accounting for just 3.8% of visits. Of the non-EU countries, the USA performs the best, accounting for 11.2% of mobile visitors, making it second only to France in the rankings

A comparison of the country location of mobile and fixed platform users produces some very interesting findings. There are on the one hand what we might call the deskbound countries, like Poland, where the mobile market share for Europeana is just one-fifth of the fixed market share and mobile ones, like Norway and the UK, where the mobile market share is, respectively 10 and 3 times the fixed share. However, this is the current situation and, in order to prepare for the future, one needs to take into account other elements. For example, although Poland is now a desktop country, the statistics (internetworldstats.com) show a great increase both in the internet and mobile penetration in the country and, with the launch of 3G mobile in Poland, it might become a large market for mobile-based internet services soon.

Combining two metrics, page views and time online, shows that the iPad provides a user experience that encourages longer, deeper sessions in Europeana and this represents a step change in behavior compared, for example, with Android users. When we introduce nationality of user into the mix, French iPad users are shown to be well ahead of the pack as the largest group and the most engaged consumers of Europeana on the go. Are the French the new mobile information pioneers? We shall find this out in the next stage of the research.

Digital Collections Accessed

The 10 most popular destinations for Europeana users on the go are shown in Table 1, with French collections highly represented in rank positions 1, 3, 4, and 5. As mentioned earlier, France is Europeana's third biggest contributor of content, so this result is not simply a function of the size of contribution. There is also genuine demand for French digital cultural content in France and worldwide. In addition, much use comes from French schools, which are highly directed towards using Europeana. In the case of Jaconde (rank 1) the explanation for its popularity may be that it has the content that French schools want in the quantity required. The explanation for the surprising second rank of SCRAN (digital content of Scottish Museums) probably lies in the relatively large amount of content they contribute.

As in so many other areas of information consumption, use of Europeana is highly skewed. The top 10 collections, which represent a little under 3% of all collections serve up just over half of all the page views made by mobile visitors (53.7%). Far from being a negative, the mirror image of this distribution is a long tail of lower intensity use across a large number of collections, providing users with great diversity and opportunities for even the most specialized and esoteric tastes to be satisfied.

Referrals

Search engines, predominantly Google, are the key drivers of visitors to Europeana, sending about 80% of traffic to the site (Figures 6, 7, data for January to July 2011). Of course, in the case of Europeana, this is very much a case of a search engine driving traffic to another gateway, and, in many cases, actually bypassing the site's search engine. The figure shows that blogs and social media, representing the wisdom of the crowd, are becoming increasingly important drivers of traffic for Europeana, accounting for 5.3% of traffic and rising. There is some Twitter use but it is not important quantitatively speaking; however, it's a good quality metric for social engagement and one of the platforms Europeana are targeting for growth. Fixed and mobile users barely differ in terms of their referral patterns, which might be a surprise given the "social" nature of the mobile platform—meaning we might expect more rather than less referrals from social media sites. But it is still early days.

TABLE 1. Top 10 most popular Europeana cultural collections viewed by mobile users, January to July 2011.

| Collection	Provider	% mobile page views
Joconde (French museums)	Culture.fr	10.1
SCRAN (Scottish museums)	SCRAN	9.0
RMN Grandpalais (French art)	Culture.fr	6.5
INA (French TV and radio archive)	Institut national de l'audiovisuel	5.5
Gallica (French monographs)	Bibliothèque nationale de France	4.6
Deutsche Fotothek (German picture archive)	Sächsische Landesbibliothek	4.5
DigitaltMuseum (Norwegian museums)	ABM Utvikling	3.8
Ga het na (Dutch national archive)	Nationaal Archief	3.7
Digitale Bibliothek (Bavarian digital library)	Bayerische Staatsbibliothek	3.0
IMC (Irish census records)	Irish Manuscripts Commission	3.0
Total		53.7
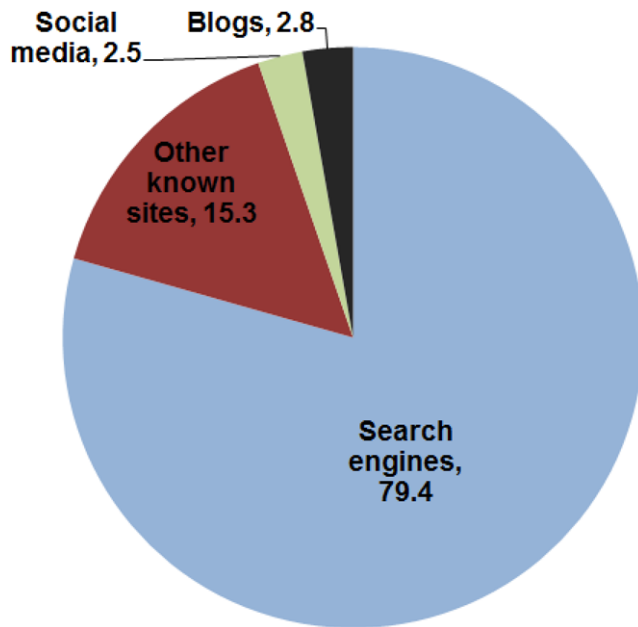
FIG. 6. Referrals to Europeana: fixed users. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]
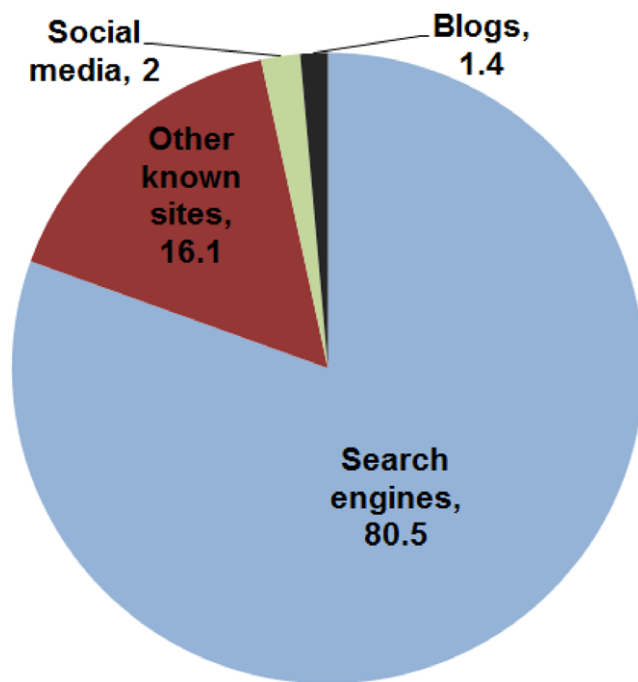

FIG. 7. Referrals to Europeana mobile users. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

Interestingly, the types of referring sites have a big impact on where people land once they arrive at Europeana. Search engines typically take them straight to a record page, blogs to the homepage, and other social media to a wider variety of entry page types.

Influence of Interface on Information-Seeking Behavior

Before the arrival of tablets, mobile devices were very limited in terms of the size and resolution of their screens;

TABLE 2. Differences in the interfaces between fixed and mobile devices.

	Fixed	Mobile
Simple search box	√	√
Choose a language	√	√
Bookmark and share	√	√
About us	√	√
Contacts	√	√
Terms of use	√	×
Advanced search	√	×
Filter search results	√	×
New content	√	×
Exploring Europeana	√	×
People are currently thinking about	√	×
MyEuropeana	√	×
Communities	√	×
Partners	√	×
ThoughtLab	√	×
Using Europeana	√	×
Accessibility	√	×
Privacy	√	×
Language policy	√	×
Back to top	√	×

they lacked a keypad or mouse, and had relatively slow processing speeds. Many internet-enabled phones suffer from these limitations and so a simplified interface, "Europeanalite," was/is essential to provide reasonable web access. Table 2 shows how limited the functionality available to mobile users is. This is bound to color the online experience and impact information-seeking behavior: that is clearly reflected in many of the following analyses and figures, with major differences arising both between how Europeana is used on fixed and mobile platforms, and between smartphones and tablets. As mentioned earlier, Europeana plans to overhaul the mobile version of the interface and the ability to filter search results is part of the requirements, along with many other features. In the new portal version of Europeana, which will be launched in 2012, tablet users will no longer be redirected to the mobile version but to the standard desktop version, hence gaining functionality.

Characteristics of Information Seeking: Dashboard Metrics

Visits from users on the go are very different in the aggregate from those from "fixed" platforms, as the dashboard of key metrics clearly shows (Figure 8). Mobile visits, as we might have expected, are typically shorter, less interactive, and less content is consumed per visit. Kamvar et al. (2009) also showed that mobile users undertake fewer queries per session as compared to desktop users. The most noticeable difference is probably in the time spent on a visit to Europeana: mobile visits are more than 10 seconds shorter, 65 seconds compared to nearly 76 seconds for fixed devices. The only metric on which mobiles score more
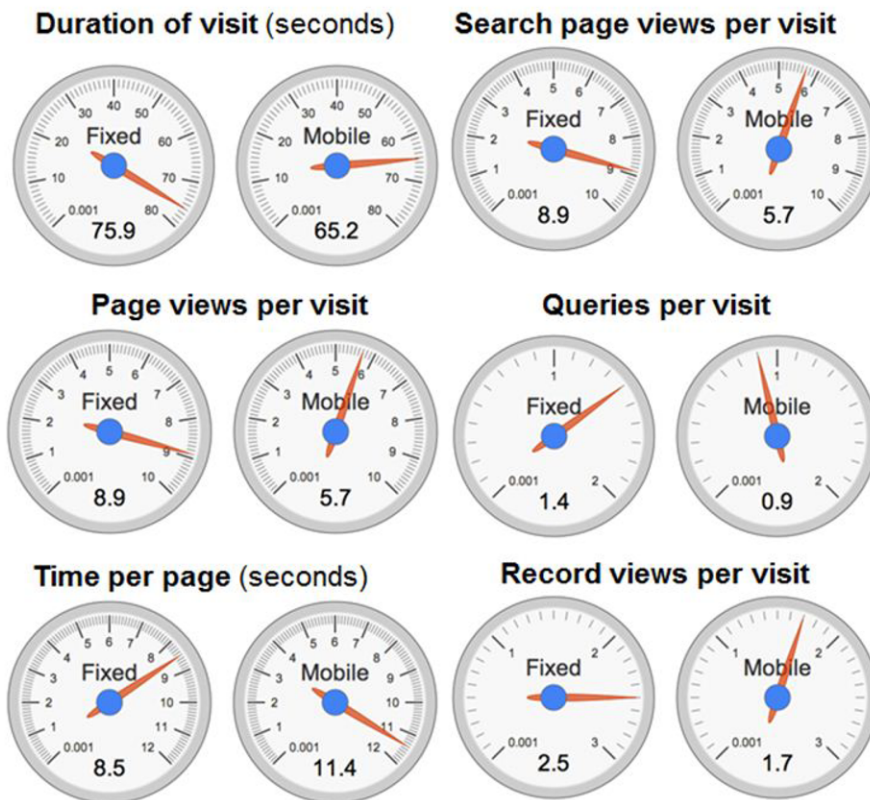
FIG. 8.   Key visit metrics for mobile and fixed users. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

highly than fixed devices is average time per page. Mobile users spend on average more than twice as long per page, but this is probably only to be expected given the relatively slow performance of some of these devices (but of course this is changing).

Very much a key characteristic of web searching is the bouncer visit, whereby, as its name suggests, just a single page is viewed and then the user exits the site. We can only guess at what bouncer visits say about user satisfaction since we do not know from the logs what the context was or motivation that brought someone to Europeana. Brief visits involving a single page view would seem to suggest not much engagement took place, although we do not know for sure whether or not the user had a positive experience. But the proportions of bouncer visits by platform type are telling. Mobile visits are nearly twice (1.95 times) as likely to be bouncing visits than is the case for normal fixed users, and more than 10 times as likely as for heavy users. We do not entirely know why this is the case, but it could be due to the fact that we know from the literature review (e.g., Sellen et al., 2002; Cui & Roto, 2008) that there is a tendency to use mobiles for fact-finding purposes, which would naturally lead to fewer pages viewed. It could also be explained by the fact that there is much variation between Europeana collection partners in the extent to which they have adapted their offerings for mobile users.

Mobile visitors are 25% more likely to view the homepage and 25% less likely to view the record than fixed users. These are big differences, which might again be attributed to the extent to which content providers have adapted their offerings for mobile users.

Similarly, the variation in behavior between the main mobile brands is large (Figure 9, data for October 2010 to July 2011). On the one hand, the limited screen real estate and slowness of the Blackberry is clearly a limiting factor for extensive and in-depth research. Visits are incredibly short, few searches are conducted, and very few pages and records are viewed. On the other hand, the tablet iPad generates usage metrics that are not very dissimilar from desktops or laptops.

Clustering of Users According to Their Information-Seeking Behavior

People visit Europeana for a wide variety of reasons, from simply finding themselves there as the result of a Google search to a planned and intensive research session. While we cannot determine the exact reasons from the logs, we can obtain some understanding by using cluster analysis to characterize users by their behavioral patterns. Cluster analysis shows that the digital footprints that visitors leave behind are clearly structured and indicates that there are

Duration of visit (seconds)

Blackberry 19.4 | iPhone 67.3 | iPad 72.9

Search page views per visit

Blackberry 0.4 | iPhone 1.2 | iPad 3.2

Page views per visit

Blackberry 3.5 | iPhone 4.2 | iPad 7.8

Queries per visit

Blackberry 0.3 | iPhone 0.7 | iPad 1.1

Time per page (seconds)

Blackberry 5.5 | iPhone 3.5 | iPad 9.3

Record views per visit

Blackberry 1 | iPhone 1.5 | iPad 2.1

FIG. 9. Key visit metrics for Blackberry, iPhone, and iPad users. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

three basic types of mobile information-seeking behavior associated with Europeana—bouncing, checking, and exploring. Comparing these categories with the ones proposed by Cui and Roto (2008), checking is similar to their fact finding and exploring is similar to casual browsing. Most visitors (52%) are "bouncers" in that they only view a single page and leave, very likely having been swept to Europeana courtesy of a general search engine like Google. A high proportion will never return, but that is not to say that they may not have extracted valuable facts or information from that visit. A large minority of mobile users (42%) make relatively brief visits of just below 2 minutes and engage in real interaction with Europeana, typically entering a single search and viewing several (3–4) pages of content. A small proportion of these visits are referrals from social media or blogging sites (a third more referrals than expected). We are provisionally associating these kinds of visits with a form of information "checking" behavior—they appear to be fact finding or checking in nature, short and sharply focused. This leaves a small minority, around 6% of visits, that are characterized by considerably longer duration (around 10 minutes) and much higher degrees of interaction with Europeana software and content. This is the kind of behavior that one would associate with a need for more in-depth research or perhaps users who are simply exploring the website to see what Europeana can offer them. In the next stage of our research we will be focusing on this group of core or persistent users.

User Satisfaction

As we have learned, logs can tell us much about information-seeking behavior, but nothing explicit about satisfaction, except perhaps by inference in the case of return visitors, and because of an absence of cookies from the logs we have not been able to conduct this analysis (but will be able to in the second round of research, when cookies will feature in the log string). There are, however, two metrics that suggest that mobile users may not be enjoying the same outcomes as "conventional fixed users" visitors. One-shot visits, where only a single page is viewed, are nearly twice as common for mobile users. It is impossible to tell whether this reflects a positive experience (they obtained what they wanted quickly; perhaps, not so demanding) or a negative one (they arrived there by accident or were not impressed by what they saw).

The second metric, the click-through, probably offers a better metric of satisfaction. A click-through is, in e-commerce terms, a "conversion," a redirect, an instance of Europeana sending traffic to a provider/collection site. As Europeana is a portal to / advertiser of (other people's) collections then this can be regarded as a hit for the provider and a "sale" for Europeana. It is the Europeana equivalent of the full text download on the publisher's platform. A click-through involves the viewing of two pages. From the user viewpoint page 1 is the Europeana Record and page 2 is the Collection Provider site. There is a big difference in click-

through rates: for fixed users, 44% of page views lead to a redirect to a content provider, but for mobile users the click-through rate is just under 17%. One possible explanation has already been furnished: Europeana partner sites vary in how they have adapted (or not) to mobile browsers. If the user notices the first time that clicking through to the providers causes an error or a very badly presented page to load they're less likely to do so again. Past works by Kamvar and Baluja (2006) on mobile searching have also shown a low click-through rate across different search categories, something that they attributed to heavy reliance of mobile searchers on snippets for their information. They also mentioned that items that require scroll action reduce the click-through rate.

Conclusions

Studies have been conducted on mobile users and their web behavior before but this study is unique in a number of ways. No previous studies appear to have covered the cultural or digital humanities field, nor do any compare behavior for the same website by users of different platforms. Neither do any cover more than a couple of months' data. Furthermore, many previously published studies concern themselves with search engine queries rather than information seeking in the round, and most were conducted before the widespread adoption of the iPad and related tablets.

Three years ago Europeana was prescient in considering the mobile user in its development plans. But during the course of this ongoing study the "mobile user" had to be redefined. First came the iPad: looking like an overgrown iPhone, from the server-side view, similar page requests destined for the same rendering engine. So we had a new category, mobile in its usage rhythm but certainly not a pocket-size display. Since then the game has changed again—we now have smartphones: mobile, pocketable (for some pockets), but with the potential to display more pixels than many desktops. So the ontology of devices inevitably changed, and so did the functions of the site. Europeana could no longer serve the same content to all mobile users. "Mobile" was no longer a useful catchall category; the differentiation that is now emerging is one between Office and Personal. The Office is tethered to the desktop, has keyboard and mouse, is for work and study, documents and organization. The Personal is the Pad and Phone, touch-sensitive and wireless, for conversation and affiliation, untethered and mercurial.

We have shown that Europeana is proving exceptionally popular for users with personal devices. Because we are starting from a very low base (in January 2010, for example, there were fewer than 3,000 "mobile" page views) it is difficult to predict the future with certainty. However, over the 12 months from August 2010 to July 2011 page views from these devices grew at a rate four times greater than office-bound devices, with the fastest growth coming from the tablets rather than phones. If these trends continue, as we confidently expect, then mobile access is likely to become a significant component of Europeana's future traffic, with considerable implications for system design.

We have found a new rhythm and pattern to use and information-seeking behavior that is more "personal" and less "professional." Information seeking and use happen in the evening and on weekends; occur in the home or "anywhere but the office." They are about consuming content, not creating it. Social networking, creates contacts and networks, but it is not about content as envisaged by those information providers who suppose "content is king." Personal use is certainly qualitatively different from desktop use, we see more short "one-shot" visitors, more use in the evening and on weekends, but surprisingly there appear to be fewer referrals from blogs and social media. Mobile information seeking is also characteristically faster, more abbreviated, and less intensive than that associated with desktops used in the office or library; it is also probably more distracted because of the social environment in which smartphones and tablets are used. It is highly likely that mobiles are extending the reach of websites, like Europeana, and drawing in a wider range of people (more digital natives perhaps), partly because they are seen to be social and "cool." Many of these new users will have little experience of traditional web information services, which often owe more to the library world than to the social one. This combined with the fact that people are generally searching on smaller devices, which typically have less functionality, also helps explain the type of information-seeking behavior that is evolving.

We have come a very long way indeed from searching for information via an intermediary and using the fruits of the search in a controlled library environment to searching and using information on the move in what is often a social space, with all the distractions it brings with it. Yet information professionals have been slow to adapt. Ask a young person today about libraries and they will point to their smartphone or tablet, and ironically these are sometimes banned from the traditional library.

We may also have a new attitude to "paying for content" emerging, which is likely to have its impact on information seeking: it would appear that "apps" do have a market even where there is traditional resistance to pay per view. Whether, in the particular case of Europeana, there is a revenue opportunity in this is an open question, which will only begin to be answered in the second stage of the study. Nor can we say if the service itself, its content providers, or some other entrepreneur may prosper.

Taking our research forward, how might the information community best position itself, both to observe and serve an evolving market? "Mobile" is no longer a suitable catch-all, and the new ontology will probably not be readily associated with easy-to-log values such as user agent. Somehow, both in web-serving and in the later analysis, we need to discover: is this user really paying attention, passive or active, big or small screen, hi-res or low-res, traditional inputs or gestures? We also need to pay more attention to when and where information seeking takes place, and how persistent it

is. Perhaps it means a parting of the ways between a traditional web-site as a store of content and a more dynamically managed, "app"-based service: paid-for, personalized, paradoxically more actively engaging with a mercurial yet passive consumer.

Acknowledgment

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