

Down the Superhighway in a Single Tome: Examining the Impact of Book Format on Borrowing Interactions

Dana McKay

University of Melbourne
Parkville, VIC 3010

dmckay1@student.unimelb.edu.au

Wally Smith

University of Melbourne
Parkville, VIC 3010

wsmith@unimelb.edu.au

Shanton Chang

University of Melbourne
Parkville, VIC 3010

shanton.chang@unimelb.edu.au

ABSTRACT

Many readers claim that the uptake of ebooks by libraries hampers their information seeking by not affording them the opportunity to browse. Conversely, readers value the convenience of anywhere-anytime access offered by ebooks. This paper aims to examine the impact of book format on borrowing patterns across a book collection. We do this by comparing usage in print and ebook collections from the same library, thus ensuring the same user population and the same discovery system. We discover a number of key differences, including borrowing frequency and number of books borrowed on a single occasion.

Author Keywords

Libraries, books, ebooks transaction log analysis, browsing, information seeking.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Library collections are increasingly moving online, especially in academic libraries (Cooksey 2004). This has many advantages for users, ebooks are searchable, accessible anywhere and anytime, and cannot be misshelved or lost (Rowlands et al. 2007). Despite these advantages, many users claim to prefer print: reasons given include eyestrain (Shelburne 2009), difficulty navigating within ebooks (Liesaputra et al. 2008), and not dealing with the unpredictable behaviour of books affected by digital rights management (DRM) software (Marshall 2010). There is one further reason given for not liking ebooks, though, and that is the subject of this paper: users note that they prefer not to use ebooks because they cannot browse library shelves to find them (Makri et al. 2007; Hinze et al. 2012).

Browsing is an important part of the library experience, and one that many users recognize is not replicated in any online system (Makri et al. 2007). A number of studies have shown that around 50% of academic library users

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or to publish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org.

OzCHI '15, December 07 - 10 2015, Melbourne, VIC, Australia
Copyright © 2015 ACM 978-1-4503-3673-4/15/12... \$15.00
<http://dx.doi.org/xx.xxxx/xxxxxxx.xxxxxxx>.

browse (Rowlands et al. 2008); (Kleiner et al. 2013), and that browsing increases the number of books borrowed, and that books shelved close together are borrowed together (Hancock-Beaulieu 1993; Losee 1993; McKay et al. 2014).

There is an increasing body of literature on how readers browse and choose print books (Reutzel et al. 1998; Hinze et al. 2012), and some studies comparing overall usage of print and ebooks (Littman et al. 2004; Christianson et al. 2005). Thus far, however, no-one has yet examined how readers select ebooks. It is similarly unclear whether the search-dominant tools on offer for ebook seeking affect selection behaviours. In this paper, we both examine ebook borrowing patterns, and compare these to print book borrowing patterns in the same library. Our aim is to understand the influence of book format and information seeking interfaces on book selection behaviour. We extend the usage log analysis techniques we created in earlier work (McKay et al. 2014; McKay et al. 2015) for print books to generate an understanding of both print and ebook use in our test collection. Understanding the differences between print and ebook provides cues as to how physical and digital library design affects borrowing, and is likely to provide insight into user needs for ebook or combined libraries moving forward. It is clear that the ability to browse affects borrowing patterns, but what about ebook constant availability, and conversely their lack of browsing facilities? In this paper we examine print and ebook borrowing patterns to understand reader needs and interaction patterns, and draw lessons for library design.

The remainder of this paper is divided up as follows: first we will discuss literature related to our work, next we will outline our methodology. Following these two sections we will present results, and then we will discuss these results in relation to the literature. Finally we draw conclusions and point to avenues for future work.

RELATED WORK

This study brings together a range of literature on information interaction, which we examine in this section. First we cover the literature comparing print and ebook use and interactions. Next we discuss the literature on the use of physical libraries, and the impact of this physical space on book selection. Finally we address the literature on information seeking generally and browsing specifically, as this is the primary interactive strategy that is not currently supported in online reading [redacted].

Print and Ebooks: Are They the Same?

There has been considerable speculation that the move to ebooks will mean the end of deep reading and academic

study as we know it (Cooksey 2004; Cull 2011). What is the evidence, though? Can these statements be supported, and how do readers feel about the issues?

In an early comparison between print and ebook circulation of the same books (Littman et al. 2004), it was discovered that ebooks were used slightly more than print books, but that both were used. Interestingly, this study demonstrated that ebooks were slightly more likely to be used in specific subject areas: computing, education, medicine and psychology. All other discipline areas showed a prevalence of ebook use. The results are in contrast with a contemporaneous study, which shows a slight prevalence of print use in a pairwise comparison, though again this is discipline dependent (Christianson et al. 2005). This subject differential is further supported by (Rowlands et al. 2007), where computer scientists were more likely to be accepting of ebooks.

User studies comparing print and ebooks show that readers value print and ebooks for different features and in different contexts. Ebooks are valued for convenience of access, searchability, copying, and not taking up space or weight (Hernon et al. 2007; Rowlands et al. 2007; Marshall 2010; Li et al. 2011). Conversely users are frustrated by navigation within ebooks, poor or non-existent annotation capacity, and the restrictions imposed by DRM (Shelburne 2009; Marshall 2010; Pearson et al. 2010). When given a choice, readers tend to prefer print books for deep reading for reasons of eyestrain and usability (Pearson et al. 2010; Hinze et al. 2012), however they prefer ebooks when 'on the move' (McKay 2011; Thayer et al. 2011). Many readers also mentioned the selection experience of print books in their decision making: they like the opportunity to browse the shelves and discover resources serendipitously (Stelmaszewska et al. 2004; Blandford et al. 2006; Makri et al. 2007; McKay 2011; Hinze et al. 2012). Some readers even gave wanting to browse as a reason for avoiding ebooks (Makri et al. 2007; McKay 2011; Hinze et al. 2012).

When we examine decision making about individual books, print and ebooks show similar patterns: cover, table of contents, index and images are used in both (Berg et al. 2010; McKay et al. 2012b). There are two fundamental differences, though: users struggle more to navigate within ebooks (Malama et al. 2004), and when ebooks have errors (such as missing or 'broken' table of contents) readers are more likely to act as though they are confused (McKay et al. 2012a). Some of the issues readers face with navigation can be demonstrably ameliorated by presenting ebooks in a realistic format, where visual cues as to book size and page location support navigation (Liesaputra et al. 2008).

Finally readers show reading comprehension differences between print and ebooks. Early research showed significantly poorer reading performance on screen than in print (Dillon 1992), though more recently these differences seem to have been largely ameliorated (Margolin et al. 2013). The one difference that demonstrably remains is the ability to remember the order of events within book narrative (Mangen et al. 2014). The physical affordances of print books support sequential

memory, though, so this finding may be of limited significance.

Ultimately, readers use ebooks in different contexts and environments from print books (Thayer et al. 2011), and value them for different features. Overall, print books seem to be more usable than ebooks (Pearson et al. 2010; Kostick 2011), and users prefer them (Shelburne 2009; Woody et al. 2010), though this may be a result of technology maturity in print. It is clear that format can affect information use: reading comprehension may be better in print than ebooks. When it comes to selection readers use similar bibliographic features to select books at the book level. What we do not know, however, is whether format affects selection and use at the collection level nor do we understand how users choose ebooks. This paper investigates those questions.

Information Seeking and Browsing

Early models of information seeking are semi-linear, though the two major ones (Marchionini 1995; Kuhlthau 1999) include searching and browsing as interleaved and repetitive activities. Since these early models, search has received significant research attention, and is relatively well supported in most information seeking interfaces (Baeza-Yates et al. 1999). In contrast, the activity labelled 'browsing' in these early models has been largely neglected in the research literature. Part of this neglect has undoubtedly been because the activities that comprise browsing are relatively unfocused, and include collection understanding, serendipitous discovery and search refinement and expansion. Later models of information seeking (McKenzie 2003; Foster 2004) concentrate more on these less-focused activities, recognising that in human information seeking search is a tiny part of a complex whole.

It is clear, then, that browsing is a common part of human information seeking, but what does it mean to browse? Bates, who wrote the seminal work on online browsing (Bates 1993), later wrote a research-heavy definition of browsing: seeing a large and varied scene, and sequentially examining objects within it while the scene remains visible in the background (Bates 2007). Given this definition, it has been noted that library shelves are ideally suited to browsing (Kleiner et al. 2013)—and that they have no electronic equivalent (Makri et al. 2007). Our earlier work (McKay et al. 2014; McKay et al. 2015) supports this notion, and further demonstrates that a simple search result presentation is inadequate for information seekers needs: browsing accounted for significantly more borrowing than search, and readily accounted for borrowings within a range of 200 books (McKay et al. 2015). Typical search systems show many fewer than 200 results on a page, and users must navigate away from a results list to examine any item in detail.

Given the discrepancy between information seeking models and information interfaces, there is a noted need for more and better browsing systems in the literature (Mikkonen et al. 2012; Joranson et al. 2014). These systems are beginning to appear as research prototypes

(Thudt et al. 2012; Kleiner et al. 2013; Pearce et al. 2014), and also as commercial tools¹, but no approach so far has been grounded in browsing research, nor has any approach been thoroughly evaluated from a user perspective.

This paper examines the impact of a browsing system (i.e. the library shelves) on book use in contrast with a more convenient option (ebooks) that offer no browsing capabilities. We know that convenience is often a key driving factor in information seeking (Tenopir et al. 2009; Connaway et al. 2011), but does the opportunity to browse, much loved by readers, trump the effect of convenience? Under which circumstances do readers access more information? This paper aims to address those questions.

Print Books and the Shelves

A number of studies of physical libraries have shown that shelf browsing is part of the behaviour of users (Hancock-Beaulieu 1993; Losee 1993; Stelmaszewska et al. 2004; Blandford et al. 2006; Makri et al. 2007; Hinze et al. 2012). Readers like to browse (Stelmaszewska et al. 2004; Blandford et al. 2006; McKay 2011; Hinze et al. 2012), and experienced library users understand that there is no comparable online system (Makri et al. 2007). It may be that part of the fascination with browsing is historically poor catalogue systems (Borgman et al. 1995; Borgman 1996), however users cite a number of advantages of browsing that no typical catalogue currently emulates. These advantages include the use of non-bibliographic relevance cues such as book size and dust (Stelmaszewska et al. 2004), the ability to sample books before committing to them (Hinze et al. 2012), co-location of similar books (Makri et al. 2007; McKay 2011) and the opportunity to experience serendipity (Stelmaszewska et al. 2004; Hinze et al. 2012). Nonetheless there are disadvantages to physical shelves: books can be missing or lost (Blandford et al. 2006), readers examine eye-level shelves more frequently (Hinze et al. 2012) and visiting the library is inconvenient (Stelmaszewska et al. 2004; Hinze et al. 2012). The ebook collection in our study has no structure analogous to a shelf; no study to date has attempted to examine whether the existence of a shelf affects either borrowing patterns or the amount of information readers access. This paper addresses that gap.

METHODOLOGY

The work presented in this paper builds on the methodology presented in our earlier works on browsing physical libraries (McKay et al. 2014; McKay et al. 2015). The first of those works uses the relative shelf location of books borrowed on the same day to demonstrate that books are borrowed in clusters based on physical location (a result also seen on a much smaller scale in earlier work (Losee 1993)). These works also demonstrate variances in reader behaviour based on context: there is more browsing-like behaviour seen on weekends, for example.

This paper extends our earlier methodology by including both print and ebooks from the same library collection. The collections in this study accessed by the same broad user population and have broadly similar topic coverage (see Figure 1), ameliorating user population and discipline effects on behaviour. The collections are also accessed through a single web-scale search interface, so the impact of search behaviour and search results presentation is not at issue. Finally, for each collection we have anonymous but persistent user identification, so we are able to examine the borrowing patterns of individual users.

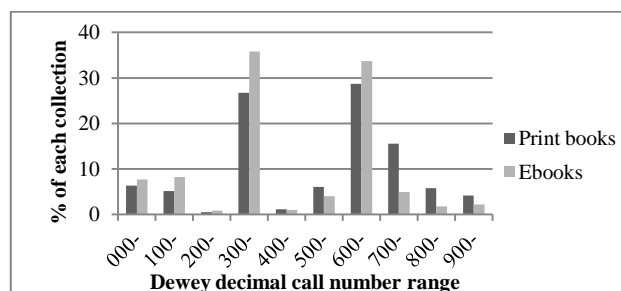


Figure 1: Subject distribution of each collection

The library in this study is the main campus library of Swinburne University of Technology, a small, research-active university in Australia. The data analysed here is from a four month period in mid-2013.

The remainder of this section will describe the print and ebook collections in detail, then discuss the tests we performed on this data.

The print collection

The print book collection is taken entirely from the main campus library at Swinburne in line with our previous approach (McKay et al. 2014). The raw data for this collection was in two files: a listing of all books and other print available in the library and loans data for the test period. The book listing included items in special collections that were shelved separately from the main collection, these items were removed and the Dewey decimal numbers converted to a standard format for easy matching and sorting. The resulting data was sorted by shelf order using Dewey numbers. The loans file included short term loans, renewals and equipment loans; all of these were removed leaving only standard loans from the main collection. Each loan records a user ID, a book title, a Dewey number, and a date. As with the shelf file, Dewey numbers in this dataset were normalized.

The ebook collection

The ebook collection is books from a single ebook provider used by the same library that houses the print collection. This provider was chosen because it provides significantly more detailed usage data than the other providers Swinburne uses.

Again, the dataset was in two files. The library file described each ebook available to readers with a title, a book ID, one or more Dewey numbers and a subject classification. We again normalized the Dewey numbers for sorting (removing any duplicates that were merely substrings of more specialized numbers), and created a

¹ See e.g. WhichBook www.openingthebook.com/whichbook/

sorted shelf (as we did for print books). Books with more than one Dewey number were marked as duplicates and recorded in all shelf locations where they could appear. This reflects a major advantage of ebooks for potential browsing: they are not tied to a single physical location. The loans file includes for each loan a date and time, an ebook ID and title, a user ID and call numbers. Call numbers in the loans file were normalised in the same way as they were in the library file.

What does it mean, though, to ‘borrow’ an ebook? Ebook providers usually allow readers to examine a small sample of a book before imposing a cost on the library; that is the model in use here. Once readers read more than a certain number of pages, print any material or copy material, they are asked to click to create a loan. Once created, this loan persists for 24 hours. It is data about these loans that we compare to print borrowing.

Loan sessions

Using the cleaned and normalized loan data described above, we created a list of loan sessions for both print and ebooks. A ‘loan session’ is the borrowing of one or more books by the same user on the same occasion. Given the differences in underlying data the ‘on the same occasion’ is defined slightly differently for ebooks and print books—for print books it is books borrowed on the same day (the lowest granularity in the data) and for ebooks it is a series of loans where the next book is used within 30 minutes of the end of the previous use. We tested a range of usage periods—lengthening the gap between books from 30 minutes to 3 hours made a smaller than 1% difference in the split between multiple and single book borrowing. The differences in session definition also reflects the natures of print and ebooks—print books are checked out all at once, to be taken away and read later, ebook loans are created during use and readers are likely to continue to read after they create a loan. For each loan session we recorded the user, the date and time, the number of books, and for each book in a session the title and call number. We also examined, for print and ebooks, the number of unique books borrowed by users: given that ebook ‘loans’ only persist for 24 hours, it seems likely that some repeat loans will be of the same book.

Day of the week effect

There is a long standing and known variation in information seeking patterns according to day of the week (Sanderson et al. 2007). Knowing that ebooks are accessible anywhere and anytime, and print books only from the library, we calculated both the number of books borrowed on each day of the week and the number of loan sessions for each day of the week to see if the ready accessibility of ebooks resulted in different borrowing patterns from print books

Shelf distance and physical proximity

To determine the likely prevalence of physical browsing—and whether this influences loan patterns in physical books in comparison with ebooks—we examined the ‘shelf distance’ between books borrowed in a single session. It is our hypothesis that ebooks will show a shorter-than-random shelf distance, due to topic clustering of co-borrowed books—after all, Dewey is a

	Print books	Ebooks
Number of books	114937	15692
Number of loans	7523	12800
Number of loan sessions	4540	11900
Number of multiple loan-sessions	1488	900
Number of books borrowed in multiple loan sessions	4470	1997
Per-day loan rate in books	61.66	113.90
Mean books per session (S.D)	1.66(1.04)	1.09 (0.36)
Median books per session	2	1
Max of books in a session	21	8
Number of unique borrowers	2725	4986

Table 1: Summary of usage, print and ebook collections

semantic addressing system (Svenonius 2000)—will show a shorter distance again. This disparity seems likely to occur as a result of users physically seeing useful books on the shelves and borrowing them without discovering them in search.

For the print books we sorted all books in a session in shelf order, then calculated the distance in number of books between each adjacent pair. For ebooks, given they can have more than one call number, we calculated the shortest distance between pairs (to assume this property helps users rather than hinders them). Sometimes this resulted in a shelf configuration that would be impossible physically; this is the potential advantage of ebooks, and we allowed it to stand.

User behaviour

The literature suggests that around 50% of print book users are ‘browsers’ (Hancock-Beaulieu 1993; Losee 1993; Kleiner et al. 2013). We wanted to test this number in our print book collection, to see whether there were any users who showed similar tendencies in the ebook collection, and to determine whether there were different patterns between the two. To this end we calculated for each user the number of sessions and books they borrowed, the number of sessions where they only borrowed a single book and the number of sessions where they borrowed more than one book. Using this data users were classified as either exclusively single borrowers, exclusively multiple borrowers, or mixed strategists. Unfortunately we cannot determine whether the same user exhibits different behaviour according to format, as the print and ebook loan systems use different user IDs.

RESULTS

In this section we examine basic statistics about each collection; then examine a number of aspects of borrowing patterns in turn: day of the week loan patterns, the number of loan sessions and co-borrowings, “shelf” browsing patterns and pair distances, and finally a comparison of user behaviour between the collections.

Summary statistics

As we can see in Table 1, usage behaviour differs significantly between print books and ebooks: there are many fewer ebooks than print books, but there are many more loans, and many more borrowers. The number of books used per session is also noticeably different between ebooks and print books: the vast majority of ebook sessions involve the use of only one book, whereas around one third of loan sessions involve more than one

print book. Multiple-borrowing sessions account for about 60% of all print books borrowed, a pattern that is not seen in ebook loans.

Day of the week

There is clear evidence of a day of the week effect in earlier literature on information seeking (Sanderson et al. 2007); an effect demonstrated for print books in our earlier work (McKay et al. 2015). Obviously some of the weekend effect in print borrowing is a result of library opening hours, an effect we would not expect to see with ebook borrowing—the perennial availability of ebooks is one of their stated advantages (Shelburne 2009). We compared ebook and print loans by day of the week throughout the study period, see Figure 2.

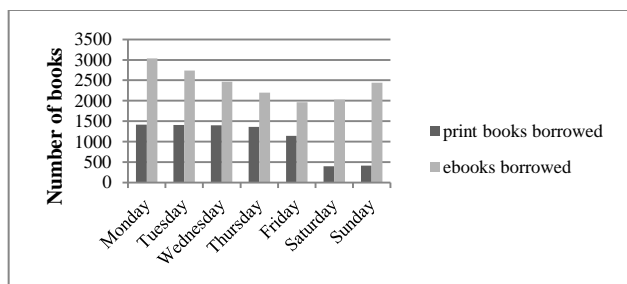


Figure 2: Books borrowed by day of the week and type

When comparing both the number of print books borrowed each day and the number of ebooks borrowed each day to random distribution using a χ^2 test, the results are statistically significant at $p < 0.0001$ (print books $\chi^2 = 1228.045$, $df = 6$, ebooks $\chi^2 = 373.762$, $df = 6$). Similarly, when we compare ebook usage to print book usage the difference in distribution is significant ($p < 0.0001$, $\chi^2 = 1048.543$, $df = 6$), showing that the ways in which print and ebooks are used are different: the distribution is not just down to when people study more generally, for example. These differences begin to build a picture of user behaviour that varies according to book format. It is likely, as noted earlier, that lower rates of print borrowing at weekends are due to shorter library opening hours and lack of classes (meaning students are not on campus). In contrast ebook loans increase at weekends, particularly on Sundays: this is likely due to the physical library being closed immediately before assignments are due on Monday mornings.

Loan sessions and co-borrowings

Now that we understand that behaviour varies according to format, we turn our attention to the proportion of all loan sessions (single instances of borrowing that incorporate one or more books) that include more than one book. The distribution is shown in Figure 3.

A much higher proportion of print book sessions than ebook sessions included more than one book ($p < 0.0001$, $\chi^2 = 1868.448$, $df = 1$): ebooks are almost invariably borrowed alone, while about 60% of all print books are borrowed in groups. When we look at the print book data more closely than Figure 3 allows, it becomes apparent that there is an artificial cut-off at ten books—many users borrowed nine or ten books at a time, but beyond this multiple borrowings were rare. This might reflect library rules about the number of books one can borrow at time,

but there is another limit in play: the weight of physical books limits the number a user can physically carry (McKay 2011; Hinze et al. 2012). Even with these limitations, though, physical books are considerably more likely than ebooks to be borrowed with other books

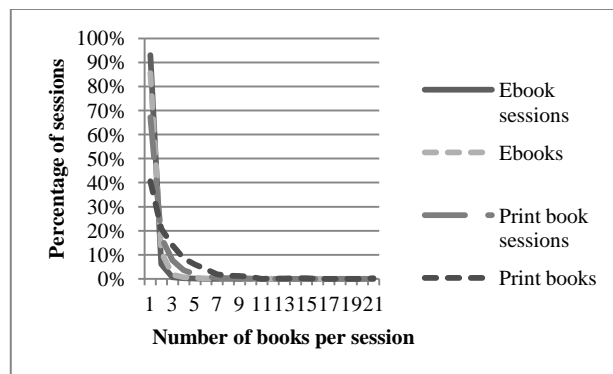


Figure 3: Number of books borrowed per loan session

Shelf or topic clustering of co-borrowed books

Ultimately shelf co-location in a physical library represents topic similarity (Svenonius 2000), a feature recognised and leveraged by savvy users (Makri et al. 2007; Hinze et al. 2012). Shelf browsing is a feature of physical libraries that users value highly (Makri et al. 2007; Hinze et al. 2012); but it remains an open question whether (for example) catalogue search results result in similar clustering.

It is already apparent from our results that ebooks are borrowed in groups less frequently than print books, but when they are, do they demonstrate the same topic clustering? To test this we examined each group of co-borrowed books. We sorted each group by Dewey number then counted the number of books between adjacent pairs. Given that ebooks can have more than one call number (see the methodology section), we always assigned the shortest possible distance between pairs—in an online environment it is possible to rearrange virtual shelves to reflect user interest, so our test reflects this advantage.

To test whether shelf browsing has an impact on borrowing behaviour, we started with the random hypothesis—random pairs would be about one third of the collection apart. We then tested our data against random distribution (half of all pairs would be more than one third of the collection apart) using a χ^2 test. See Table 2 for results:

Looking at Table 2, there is topic clustering by Dewey in both print and ebook collections, however on first glance it appears stronger in the print collection (note that the

	Print books	Ebooks
Number of pairs	2983	1097
Mean distance (s.d.)	5785.73 (16133.75)	2544.79 (3798.71)
Median distance	56	712
Significance over random	$p < 0.0001$, $\chi^2 = 2281.246$, $df = 1$	$p < 0.0001$, $\chi^2 = 398.287$, $df = 1$

Table 2: Distance between co-borrowed pairs

larger mean in the print collection reflects a larger collection size). We tested this using a one-tailed Fisher's Exact test; the results were significant at $p < 0.0001$, demonstrating that tighter topic clustering in the print collection than the ebook collection. This, given the existence of actual physical shelves, is as we would expect—the topic clustering in ebooks can only be explained by search, but print books have two opportunities to be co-discovered (searching and browsing). It may be that this tight clustering in print books reflects mere opportunism, or it may be that users of ebooks are merely using books they can find, and more closely related books that they did not find in search would have met their needs better. It is a disadvantage of using log analysis that we cannot know how satisfied readers were with the books they found. What we do know, though, is that this data reflects earlier work on the use of libraries: one of the reasons readers choose print collections is precisely this opportunity to browse (Stelmaszewska et al. 2004; Makri et al. 2007; McKay 2011; Hinze et al. 2012).

Individual User Borrowing Patterns

Unfortunately, as noted in the methodology section, we cannot track user behaviour between print and ebooks. We can describe the behaviours seen in each collection, however, particularly noting the presence or absence of borrowing multiple books in a session.

	Print books	Ebooks
Total unique users	2725	4984
Exclusively single loans	1675	4304
Exclusively multiple loans	621	128
Mixed	382	552
Mean sessions per user (s.d.)	1.67 (1.39)	2.58 (2.66)
Median sessions per user	1	2
Mean total books per user (s.d.)	2.76 (3.54)	3.38 (4.01)
Median total books per user	2	2
Mean unique books per user (s.d.)	2.66 (3.23)	3.12 (3.54)
Median unique books per user	2	2

Table 3: User behaviour across all users

Clearly ebook users, while they borrow fewer books per session (see Table 3) are more likely to visit multiple times. This difference is also borne out by the maximum number of visits by any user—for the ebook collection it was 43, or one every third day, whereas for the print collection it was 30—roughly three quarters of the number of ebook sessions. Print book users are more likely to visit the library only once, but borrow more books on that visit. The difference in strategies—single loan only vs. multiple loan only vs. mixed—is statistically different between ebook users and print book users ($p < 0.0001$, $\chi^2 = 1463.362$, $df = 2$).

	Print books	Ebooks
Number of users with multiple visits	927	2563
Exclusively single loans	382	1997
Exclusively multiple loans	118	14
Mixed	427	552

Table 4: Borrowing strategies for multiple visiting users

When we examine only those users who have multiple sessions on record (and therefore have the opportunity to employ a mixed strategy) the proportions of users in each behaviour pattern (single loan only, mixed strategies, multiple loan only) look quite different (See Table 4).

Among 'regular' users of the physical library, the number who always or sometimes borrow more than one book begins to look very like the 50% of users who claim to or are seen to browse in other print collections (Hancock-Beaulieu 1993; Kleiner et al. 2013; McKay et al. 2014). The ebook collection on the other hand has very few users demonstrating 'browsing' behaviour: this suggests that either ebook access methods do not facilitate browsing; browsers do not use ebooks, or both. Again, the difference in patterns between print and ebooks is significant ($p < 0.0001$, $\chi^2 = 1472.210$, $df = 2$).

Potentially more interesting is the number of unique books per user: with a short loan period and high convenience, it seems plausible that ebooks are more likely to be loaned repeatedly by the same reader than print books. There are no significant differences in the number of total and unique books per reader for either print or ebooks, though re-borrowing is more common in ebooks than print books. Even with this higher rate of re-borrowing though, readers access more unique ebooks than print books (Mann-Whitney, $U = 14163370.5$, $n_1 = 4984$, $n_2 = 2725$, $p < 0.01$). Clearly convenience trumps browsing opportunity when it comes to promoting borrowing, however as we will discuss below, readers should not need to choose between these features.

DISCUSSION

Perhaps the most striking difference between ebook and print book usage in this study is the difference in borrowing strategies: the ebook collection sees frequent visits with single books borrowed each time, whereas the print book collection sees rarer visits with larger numbers of books borrowed in a session. This dichotomy is also seen between user groups—ebook users are very likely to employ the 'grab-and-go' technique seen in (Buchanan et al. 2011) (though not in (Hinze et al. 2012)), and very unlikely to use a mixture of strategies. In contrast while 'grab-and-go' is common in print books, mixing strategies and exclusively borrowing multiple books is more common. Ebooks are more likely to be used at weekends, print books during the week. Print books are borrowed in tight Dewey clusters, whereas ebooks show some subject relationships but are clustered more loosely.

It is clear that convenience is a factor in accessing ebooks—they are borrowed around the clock, and more frequently when the library is closed. This reflects readers' commentary on ebooks in previous literature (Rowlands et al. 2007; Shelburne 2009; Li et al. 2011), and our understanding of the role of convenience in information seeking (Connaway et al. 2011). This paper is, to our knowledge, the first confirmation of the convenience of ebooks based in usage data.

In contrast to ebooks, we know readers find print books in libraries inconvenient to access (Stelmaszewska et al. 2004; Blandford et al. 2006), but that many readers

embrace the opportunity to browse the shelves (Stelmaszewska et al. 2004; Blandford et al. 2006; Makri et al. 2007; McKay 2011; Hinze et al. 2012). As we would expect, our data shows that shelf location does influence borrowing, and confirms that print books are more likely to be borrowed in groups. Multiple borrowing is likely to be due to a combination of serendipitously discovered resources, and readers attempting to maximise the value of an (inconvenient) trip to the library (Stelmaszewska et al. 2004; Makri et al. 2007).

What would an ideal user experience look like, given what we know about the usage of different collections? It seems almost certain that readers borrowing ebooks have a limited understanding of what is actually available to them, given that there are no shelves or other mechanisms for collection understanding in place. Conversely readers may not be finding the best resource for their needs because it is on the shelves and the library is closed, or it has been checked out when they have the opportunity to browse (Blandford et al. 2006). It seems likely that the best solution for users is the convenience of ebooks with support for browsing behaviour to meet their information seeking needs. Online browsing would facilitate collection understanding and serendipitous discovery (Kuhlthau 1999; Makri et al. 2007), and potentially support readers in finding better information resources than search alone (Cooksey 2004). It should also support the things readers currently value about browsing—the use of non-bibliographic relevance cues and the ability to dip in and out of books, for example (Stelmaszewska et al. 2004; Blandford et al. 2006; Makri et al. 2007; Marshall 2010; Hinze et al. 2012).

Online browsing is not merely an imperative, it could better support readers than the physical shelves. Our ebook data shows that readers find books that would be distant on physical shelves relevant to a single information need, a finding that is supported by early work on borrowing (Losee 1993). Given that electronic shelves can be rearranged to support information seeking in a way that centres readers' interests and electronic books are never missing from the shelves (Marshall 2010), online browsing presents opportunities for significant user experience gain over traditional shelves. While our understanding of how to provide this browsing online is currently limited, there is little doubt that to do so would be fruitful for readers.

CONCLUSIONS

In this paper we have examined borrowing patterns in a print collection and an ebook collection, and discovered that they are quite different. While we cannot tell which readers in our study were accessing books in both formats, we can speculate on their behaviour using each format.

The ebook collection sees repeated 'grab-and-go' borrowing of single books, perhaps a reflection of the convenience of accessing the ebook collection anywhere and anytime, perhaps reflecting the near impossibility of browsing. Print books were considerably more likely to be borrowed in a multiple-loan session than ebooks, showing that users stock up when they visit the library in

person. When looking at books used in a single session, there is considerable clustering along a topic based 'shelf' with ebooks, but this clustering is much closer with print books, suggesting the physical shelf (and thus browsing) does affect borrowing patterns. Readers used a slightly greater number of unique books in the ebook collection than the print collection, showing that convenience has an edge over the ability to browse when it comes to actually accessing information. This finding is in contrast with the literature showing how much readers enjoy and rely on browsing. Ultimately readers should not have to choose between browsing and convenience: a good online information experience would afford browsing as well as convenience, rather than instead of it. How best to provide the browsing facilities readers need remains a question for future work.

ACKNOWLEDGMENTS

The authors thank Kim Tairi from Swinburne University of Technology Library for facilitating access to the data used in this paper. They also thank Justin Kelly, Tony Davies, and John Butera for providing data sets.

REFERENCES

- Baeza-Yates, R. and Ribeiro-Neto, B. Modern information retrieval, ACM press New York (1999).
- Bates, M. J. The design of browsing and berrypicking techniques for the online search interface. *Online Inform Rev* 13, 5, (1993) 407-424.
- Bates, M. J. What is browsing--really? A model drawing from behavioural science research. *Inform Res* 12, (2007).
- Berg, S. A., Hoffmann, K. and Dawson, D. Not on the Same Page: Undergraduates' Information Retrieval in Electronic and Print Books. *J Acad Libr* 36, 6, (2010) 518-525.
- Blandford, A., Rimmer, J. and Warwick, C. Experiences of the Library in the Digital Age. *Proc. CCCDT 06, Foundation of the Hellenic World.* (2006).
- Borgman, C. L. Why are online catalogs *still* hard to use? *JASIS* 47, 7, (1996) 493-503.
- Borgman, C. L., Hirsh, S. G., Walter, V. A. and Gallagher, A. L. Children's searching behavior on browsing and keyword online catalogs: The Science Library Catalog project. *JASIS* 46, 9, (1995) 663-684.
- Buchanan, G. and McKay, D. In the Bookshop: Examining Popular Search Strategies. *Proc. JCDL 11, ACM.* (2011), 269-278.
- Christianson, M. and Aucoin, M. Electronic or print books: Which are used? *Libr Collect Acquis* 29, 1, (2005) 71-81.
- Connaway, L. S., Dickey, T. J. and Radford, M. L. "If it is too inconvenient I'm not going after it:" Convenience as a critical factor in information-seeking behaviors. *Lib Inform Sci Res* 33, 3, (2011) 179-190.
- Cooksey, E. B. Too Important to Be Left to Chance—Serendipity and the Digital Library. *Science & Technology Libraries* 25, 1-2, (2004) 23-32.

- Cull, B. W. Reading revolutions: online digital text and implications for reading in academia. *First Monday* 16, 6, (2011).
- Dillon, A. Reading from paper versus screens: A critical review of the empirical literature. *Ergonomics* 35, 10, (1992) 1297-1326.
- Foster, A. A nonlinear model of information-seeking behavior. *JASIST* 55, 3, (2004) 228-237.
- Hancock-Beaulieu, M. Evaluating the impact of an online library catalogue on subject searching at the catalogue and at the shelves. *J Doc* 46, 4, (1993) 318-338.
- Hernon, P., Hopper, R., Leach, M. R., Saunders, L. L. and Zhang, J. E-book Use by Students: Undergraduates in Economics, Literature, and Nursing. *J Acad Libr* 33, 1, (2007) 3-13.
- Hinze, A., McKay, D., Vanderschantz, N., Timpany, C. and Cunningham, S. J. Book selection behavior in the physical library: implications for ebook collections. *Proc. JCDL '12, ACM.* (2012), 305-314.
- Joranson, K. M., VanTuyl, S. I. and Clements, N. e-Browsing: Serendipity and questions of access and discovery. *Proc. Charleston Conf, Purdue University Press.* (2014).
- Kleiner, E., Rädle, R. and Reiterer, H. Blended shelf: reality-based presentation and exploration of library collections. *Proc. CHI 13, ACM.* (2013), 577-582.
- Kostick, A. The Digital Reading Experience: Learning from Interaction Design and UX-Usability Experts. *Publishing Research Quarterly* 27, 2, (2011) 135-140.
- Kuhlthau, C. C. Inside the Search Process: Information Seeking from the User's Perspective. *JASIST* 42, 5, (1999) 361-371.
- Li, C., Poe, F., Potter, M., Quigley, B. and Wilson, J. UC Libraries Academic e-Book Usage Survey. University of California, Springer, California Digital Libraries (2011).
- Liesaputra, V. and Witten, I. H. Seeking information in realistic books: a user study. *Proc. JCDL 08, ACM.* (2008), 29-38.
- Littman, J. and Connaway, L. S. A Circulation Analysis of Print Books and E-Books in an Academic Research Library. *Libr Resour Tech Serv* 48, (2004) 256-262.
- Losee, R. M. The relative shelf location of circulated books: A study of classification, users, and browsing. *Libr Resour Tech Serv* 37, 2, (1993) 197-209.
- Makri, S., Blandford, A., Gow, J., Rimmer, J., Warwick, C. and Buchanan, G. A library or just another information resource? A case study of users' mental models of traditional and digital libraries. *JASIST* 58, 3, (2007) 433-445.
- Malama, C., Landoni, M. and Wilson, R. Fiction Electronic Books: A Usability Study. *Proc. ECDL 04, Springer Berlin / Heidelberg.* (2004), 69-79.
- Mangen, A. and Kuiken, D. Lost in an iPad: Narrative engagement on paper and tablet. *Scientific Study of Literature* 4, 2, (2014) 150-177.
- Marchionini, G. *Information Seeking in Electronic Environments.* Cambridge, UK, Cambridge University Press (1995).
- Margolin, S. J., Driscoll, C., Toland, M. J. and Kegler, J. L. E-readers, Computer Screens, or Paper: Does Reading Comprehension Change Across Media Platforms? *Appl Cog Psych* 27, 4, (2013) 512-519.
- Marshall, C. C. *Reading and Writing the Electronic Book.* Chapel Hill, NC USA, Morgan & Claypool (2010).
- McKay, D. Gotta keep 'em separated: Why the single search box may not be right for libraries. *Proc. CHINZ '11, ACM.* (2011), 109-112.
- McKay, D., Buchanan, G. and Chang, S. Tyranny of Distance: Understanding Academic Library Browsing by Refining the Neighbour Effect. Springer. (2015), To Appear.
- McKay, D., Buchanan, G., Vanderschantz, N., Timpany, C., Cunningham, S. J. and Hinze, A. Judging a book by its cover: interface elements that affect reader selection of ebooks. *Proc. OzCHI 12, ACM.* (2012a), 381-390.
- McKay, D., Hinze, A., Heese, R., Vanderschantz, N., Timpany, C. and Cunningham, S. J. An Exploration of ebook Selection Behavior in Academic Library Collections. *Proc. TPDL '12, Springer.* (2012b), 13-24.
- McKay, D., Smith, W. and Chang, S. Lend me some sugar: Borrowing rates of neighbouring books as evidence for browsing. *Proc. DL 2014.* (2014), 145-154.
- McKenzie, P. J. A model of information practices in accounts of everyday-life information seeking. *J Doc* 59, 1, (2003) 19-40.
- Mikkonen, A. and Vakkari, P. Readers' search strategies for accessing books in public libraries. *ACM.* (2012), 214-223.
- Pearce, J. and Chang, S. Exploration without Keywords: The Bookfish Case. *Proc. OzCHI 2014, ACM.* (2014), 76-79.
- Pearson, J., Buchanan, G. and Thimbleby, H. HCI design principles for ereaders. *Proc. Booksonline '10, ACM.* (2010).
- Reutzel, D. R. and Gali, K. The Art of Children's Book Selection: A Labyrinth Unexplored. *Reading Psychology* 19, 1, (1998) 3-50.
- Rowlands, I. and Nicholas, D. Understanding Information Behaviour: How Do Students and Faculty Find Books? *J Acad Libr* 34, 1, (2008) 3-15.
- Rowlands, I., Nicholas, D., Jamali, H. R. and Huntington, P. What do faculty and students really think about e-books? *Aslib Proceedings* 59, 6, (2007) 489-511.
- Sanderson, M. and Dumais, S. (2007). Examining Repetition in User Search Behavior. *Advances in Information Retrieval. G. Amati, C. Carpineto and G. Romano, Springer Berlin Heidelberg.* 4425: 597-604.
- Shelburne, W. A. E-book usage in an academic library: User attitudes and behaviors. *Libr Collect Acquis* 33, 2-3, (2009) 59-72.

- Stelmaszewska, H. and Blandford, A. From physical to digital: a case study of computer scientists' behaviour in physical libraries. *IJDL* 4, 2, (2004) 82-92.
- Svenonius, E. *The Intellectual Foundation of Information Organization*. Boston, MA, USA, MIT Press (2000).
- Tenopir, C., King, D. W., Edwards, S. and Wu, L. Electronic journals and changes in scholarly article seeking and reading patterns. *Aslib Proceedings* 61, 1, (2009) 5-32.
- Thayer, A., Lee, C. P., Hwang, L. H., Sales, H., Sen, P. and Dalal, N. The imposition and superimposition of digital reading technology: the academic potential of e-readers. *Proc. CHI 11, ACM*. (2011).
- Thudt, A., Hinrichs, U. and Carpendale, S. The bohemian bookshelf: supporting serendipitous book discoveries through information visualization. *Proc. CHI 12, ACM*. (2012), 1461-1470.
- Woody, W. D., Daniel, D. B. and Baker, C. A. E-books or textbooks: Students prefer textbooks. *Computers & Education* 55, 3, (2010) 945-948.