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Citation: Buchanan, G., McKay, D. & Makri, S. (2019). Take Me Out: Space and Place in Library Interactions. In: Proceedings of ACM Conference on Human Information Interaction and Retrieval (CHIIR'19). . New York, USA: ACM. ISBN 9781450360258

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Take Me Out: Space and Place in Library Interactions

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ABSTRACT

Information interactions are strongly affected by the place where they occur. Specific locations are often associated with searches on particular topics, and individual users perform different tasks in habituated places. A classic example of habituated space is the commuter who regularly reads the news on the train. This paper investigates these associations through four user studies that examine different uses of place in information interaction. Through this, we reveal the ways in which the location of information interactions makes them effective or ineffective. This extends our interpretation of the role of place in information interaction beyond established foci such as location-based search.

CCS CONCEPTS

• Human-centered computing~Empirical studies in HCI • Human-centered computing~Ubiquitous and mobile computing theory, concepts and paradigms

KEYWORDS

Digital libraries, space and place, information interaction.

ACM Reference format:

George Buchanan, Dana McKay and Stephann Makri. 2019. Take Me Out: Space and Place in Library Interactions. In *Proceedings of ACM Conference on Human Information Interaction and Retrieval (CHIIR'19). ACM, New York, NY, USA, 9 pages.* https://doi.org/10.1145/3295750.3298935

1 Introduction

Information users' current location often influences their goals and behaviour when interacting with information. At a museum, for example, users often will search online for ideas inspired by the artefacts in front of them. However, location can have more subtle effects, such as a user searching for information on a hobby while having their morning coffee. For the average person, that coffee shop will have no particular association with crochet, but for the person who regularly reads up about their hobby, there will be.

Location and place are often used interchangeably, but in human-computer interaction, there is a conceptual distinction between space and place [1]. Space is 'real-world' three-dimensional space, and its arrangement and shape can inhibit or enable behaviours. Place, on the other hand, is a concept drawn from architecture: the expected role and function of a particular location. Adapting the well-known adage, a house is just a space, but a home is one's own place.

Location-based search is a well-established tool in information retrieval. Researchers have abstracted beyond specifics of location such as longitude and latitude. A search for a restaurant can draw from GPS data to name the current location, or calculate distance. Previous activity in a location can aggregate to reveal something of its meaning and associations with the searches done there. Both named and GPS locations can also be semantically mapped to particular meanings through a variety of methods of reasoning.

However, there are gaps between the IR use of location and the HCI understanding of place. In IR 'place' is sometimes used to describe semantic associations with a location [2] In this case, place influences the search algorithm, and what material it reports to the user. Interaction designers consider place not only as an influence on the best outcome of a task, but as adjusting the structure of the task, or even the choice of task to do. In information interaction, both approaches have to be considered.

Libraries are long-established as a place for discovering and working with information. They are typically physical, but for the last twenty years have also existed in digital form. The conception of place from architecture has been applied to libraries to understand social uses of library buildings [3]. However, this sheds little light on how information work is done.

Digital content has and is transforming the use of libraries—e.g. nearly all journal articles are accessed online. Libraries are also investing heavily in digital content; the proportion of books in UK libraries in digital form has increased from 20 to 30 percent since 2014; in Australia over 90% of university library book holdings are now ebooks. There is considerable ignorance of and resistance to the use of digital resources though, some of which is related to the physical realities of the library. Digital books are difficult to browse, and invisible to the 50% of information seekers who use shelf-browsing as part of their information seeking.

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CHIIR '19, March 10–14, 2019, Glasgow, Scotland UK
© 2019 Copyright is held by the owner/author(s). Publication rights licensed to ACM.
ACM ISBN 978-1-4503-6025-8/19/03 $15.00
https://doi.org/10.1145/3295750.3298935

Digital content is convenient however, and where information seekers do access it, the library expands both in space and time.

This paper reflects on four studies that have sought to use the physical space of the library in combination with mobile devices to support users' interactions with information. Libraries are still well-used in universities as places of study, and the physical space is still strongly influenced by print holdings. Our studies span a seven-year period, and highlight a range of issues of space and place in libraries. The paper proceeds as follows: first we recap related literature from interaction design, library science, information retrieval and information interaction; we summarise four studies before describing them in chronological order; then, we synthesise the findings of the four studies, and contrast our insights with the existing literature. Finally, we conclude with a summary of our contribution and a consideration of future work.

2 Background

Space and place have long interactions with HCI, libraries, information interaction and information retrieval. This section discusses space and place in each domain, drawing first on HCI.

2.1 Space and Place in Interaction Design

Paul Dourish has been the main proponent of the understanding of place and space in interaction. In 1996, Harrison and Dourish introduced the concepts in the context of HCI [1]. Ten years later, Dourish reflected on the earlier paper [4], specifically addressing the need to reconsider the concepts after the emergence of mobile computing. In particular, Dourish then argued 'against the simple dualism' that he felt had emerged in the use of the two terms—that place often was constructed from the practiced use of particular space, and that space was also often created to make a place for particular uses, saying 'Place and space are both products of social practice, albeit different systems of practice'.

Dourish noted the temptation and potential value of typologies in combining space and place, particularly citing [5]. His main concern was that this stemmed from a 'separation of space and place into two different domains'.

Despite Dourish's concerns about the terms he helped introduce, others have adopted or extended the approach. Recently, for example, the theory of proxemics has been used to complement the space/place concept [6].

2.2 Place and Space in the Library

One of the fundamental features of the library is its location as a place in the shared social consciousness. However, what a library 'means' has moved over time.

The 'Carnegie model' of libraries (see [7]) now frames what most people experience as the norm of libraries. Open-stack shelving means that readers can physically browse at least the most active parts of the library's holding. This proved a powerful improvement over older closed-stack libraries, where a reader had to consult card indexes and request a known item.

This model is badly disrupted by digital technologies. In principle, readers of a university library can take out ebooks at any time in any location: everywhere is now an 'open-stack'. While library users praise this convenience [8; 9], ebook uptake is slow and reluctant [10]. The reasons readers give for not using ebooks include intrusive digital rights management, bad support for annotation, poor reading experience, lack of serendipitous discovery when using online materials and an overall preference for print [8; 9; 11-13]. These limitations mean that the 'online place' of the digital library does not serve its users as well as the physical counterpart; in turn interactions with it will look very different than physical interactions.

The key value of open-stack browsing was identified as early as 1969, when Levine referred to shelf browsing as a 'pleasurable process of exploration' [14]. Later studies have confirmed shelf browsing as a valuable activity, painting the library stacks as sources of information and inspiration [9; 15-17]. The shelves support discovery so well, in fact, that they have been described as a 'browsing engine' [18].

Academics value libraries as places to work without distraction, even going so far in one case as to refer to them as 'sacred' [10; 17]. Student use of libraries also places a heavy emphasis on quiet, solo study [19; 20]. This view of libraries may seem anachronistic, but it is recently supported (2017) by Warwick who notes that elements of the physical library experience are 'wonderous': e.g. 'an intense sense of fascination and attraction that strikes a visitor when they walk through the door to the actual resource'. (p. 11) [21]. Library spaces are well designed to support such solo activities.

In contrast to the social ideal of libraries as places of quiet, solo reflection and individual serendipitous discovery, modern academic libraries host significant group and social activity [20; 22]. This activity is sometimes purely academic, sometimes purely social, and sometimes a mix of the two [23]. It is a clear expectation, though, particularly among students, that the library should support group work, and their space should offer a distinction between group and solo use [20; 23; 24]. This is not the only tension between the library as place—the concept of the library—and the library as space. A recent study notes the two in direct conflict, with the silence and scholarliness of the place interfering with the ability to browse, and so limiting the functionality of the space [25].

What is noticeably absent from all these discussions of library space and place, though, is a consideration of online resources or materials. While there has been some argument for the consideration of online resources as part of both library space and place (e.g. [26; 27]), digital resources are notable for the absence of any hint of their existence in the physical space of the vast majority of libraries.

2.3 Place and Space in Information Retrieval

As noted in the introduction, space and place have in various ways been considered in information retrieval. Some recent work on mobile IR has started to fuse elements of the understanding of place in HCI with traditional concerns IR. Karen Church's recent work [28], includes an analysis of both where mobile information work, particularly searches, occurred and the social context in which they occurred. This revealed that search is often done, for example, at home in the presence of family, and individuals have

established routines. While this has not yet led to novel algorithms, the fusion of social, personal, chronological and location information in that analysis is very close to HCI's understanding of place, rather than traditional location-based IR.

Other researchers have established that geographical locations can particularly trigger searches based on the real-world role of those places. For example, museums often provoke incidental searches based on their artefacts [29].

2.4 Place and Space in Information Interaction

There have been some—albeit limited—attempts to blend physical and digital information spaces in libraries. Kleiner et al's Blended Shelf [18] offers a virtual library shelf browsing experience which aims to augment physical shelf browsing. Blended Shelf incorporates real-world attributes of books, such as size and availability, but allows users to dynamically sort items on the shelf by a range of attributes e.g. title or subject. Martin et al [30] present a conceptual app design STAK (Serendipitous Tool for Augmenting Knowledge). The app aims to allow users to access digital material to complement what they see on the library shelves. Based on user modelling, STAK infers user interest by tracking when user linger in a particular location, then uses user modelling to recommend nearby items of interest.

Blended spaces have the potential to both leverage libraries' investments in online resources and improve library user experience. Even so, blending physical and digital spaces should be approached with caution, Warwick [21] notes the 'danger of technocratic arrogance if we assume everything can be modelled digitally and thus improved' (p. 11). She further argues that a purely 'digital library' seems a misguided goal. Rather than reproduce a physical library in digital form, designers should aim to create useful digital resources that can be used in physical libraries. This paper reports on a number of attempts to do exactly that, further it notes some commonalities in what they reveal not just about space and place in the library, but about how mobile services in particular can improve them.

2.5 Summary

We have examined the ways in which space and place have been considered in interaction design. While the concepts are well-cited and used in interaction design overall, they have received surprisingly little consideration in information interaction. Location- and context aware systems address some of the same concerns, but they typically avoid the physical internal architecture associated with spaces, and the social construction of places. Typical location- and context-aware information finding tools align, in most cases, with Harrison and Dourish's conception of space—i.e. a physical location. The social construction of place is, however, more complex than simple geography.

In the context of libraries, there are many ways in which space and place are connected. This almost exactly mirrors the caution urged for by Dourish not to split the two as a duality. At the same time, this co-location of the two in traditional libraries allows us to understand the two as disparate lenses to understand a user's interaction with the space, a mobile device or mobile service.

The main body of this paper uses this approach, taking four studies of prototype mobile systems that are located in library spaces. Each is intended to enhance the user's engagement with library holdings—in some cases print books, in others online journals. Some have been reported elsewhere, focusing on the design and development processes. Here we focus on how each system uses physical space, and then in turn on how place influences the type and level of benefit each mobile app provides. Finally, we discuss how the responses to each prototype can inform how we consider place in the context of mobile interaction.

3 Programme of Research

We report four studies of different prototype systems, each of which uses space to improve the user experience of libraries.

The first study used observations and interviews in university libraries to gather requirements for a location- and context-aware mobile system. This system used a user's location within the library (space) and the context of the books on their desks (information place) to focus and filter catalogue search. This study—and the observations and interviews that were its cornerstone—informed the rest of the program of research.

The second study aimed to address low awareness of, and difficulties in accessing, online databases amongst library users. This system used the large displays in libraries as a means of transmitting information, but relied on users' mobile phones to allow them to capture the information and take it with them.

The third study built on the first two—adjusting the focus on finding ebooks of potential interest rather than whole collections. This used print books of interest as a proxy for physical space, resulting in an intriguing divergence of space and place.

Finally, we used a digital app space to address one of the problems of library space: books on a similar topic shelved at a geographic distance due to the vagaries of classification schemes.

4 Study 1: Using Space to Focus Search

Our first study sought to use the library space as a clue to the reader's topical interests. The primary approach was to filter by topic the content of the library's online catalogue. A search done on 'resilience' would produce different results for users in the psychology and engineering sections. The two disciplines use the same term in sharply differing ways, and filtering avoided distracting 'false positive' matches. We were thus using space as place to refine the user's interaction with the library catalogue.

4.1 Design

The design focussed on the use of laptops and smartphones. The location sensing in the building was done using Bluetooth beacons, and the reader's location was resolved to a physical space and topical place (e.g. 2nd floor, west wing, history section).

After initial pilot work the design was refined for testing. Full details are available in [31]. The final functions included the following changes to the library catalogue interface: 1) restricting search results to topics near the user's location; 2) highlighting online databases on the topics near the user's location(e.g. the ACM library in computer science, or Early English Books online

in English Literature) by a panel to the right of the usual search display; 3) the ability to scan a book's RFID tag to trigger a search on the book's topic in the library catalogue.

The pilot study provided insights into the use of space—most users of the library adopted particular locations in the building, and were repeatedly seen at the same location on different days. The books piled on a reader's desk (often two or more in total) suggested their task, and those who worked remotely from the shelves for their topic more often had larger numbers of books—quite possibly to save repeated journeys across the library [31]. Interviews revealed that those working away from their topic location did so for privacy or silence—e.g. one graduate student said 'I really need somewhere quiet I can concentrate in', while a faculty member said 'it's good to be away from where people expect to find me—I don't get interrupted'.

The design drew on these observations, providing RFID scanning to allow the user to prime the topic of interest from the books on their desk, and their location to identify online content and focus their search results. As users in most cases used space near their area of interest, suggesting related material would focus their search results on books that would more likely be useful.

4.2 User Study

We recruited ten participants who used the prototype in situ, using a provided laptop computer. The participants completed chosen tasks that they chose themselves in advance of the session. Subjective feedback favoured specific features: using a single book to trigger a search was preferred, due to a greater sense of control. Knowledge of the library space or place led to users explicitly adjusting their plans: e.g. one participant said of a book 'Oh, that's not on this floor—it's downstairs. It may be useful but I'd have to be sure to take the trip'. This was typical of the seven participants who looked at a book's topic headings, six of whom rejected a book due to its topic seeming too marginal, or the distance to it being too great.

Eight participants explored the related online resources lists, and all of those found one or more new sources of information that they rated 'useful' or 'very useful'. One comment was that 'I wouldn't need this every time, but I'm finding stuff that I'm sure I've missed for years'. As this adjustment was a simple panel on their library search screen, it suggests that users were able to discern relatively minor adjustments to a familiar digital place.

4.3 Summary

This study showed that most users followed the library's design of place by using the areas where the books on their topic resided. A minority chose a distant writing location, and used a bigger pile of books to save time fetching books. The content of the reader's desk was a more reliable indication of their interests than their physical location. Users could adopt their own regular 'place' for study away from their topic shelves, and would repeatedly be seen at the same location, suggesting a personally rehearsed combination of space and place. The study directly informed two following studies, that each focussed on different elements of the initial prototype.

5 Study 2: Promoting Online Collections

Our second study deployed a public electronic display in a library, to promote the availability of online databases (primarily, but not exclusively, of journals) to the library's readers. It is a common problem in libraries that electronic holdings are used much less than expected. Users are unaware of the range of material available, and electronic databases are invisible in the main library catalogue.

This design was independent of the first study. In concert with the subject librarians at a research-focussed London university, we identified a number of under-used online databases that were understood to be of potential value to students. An initial survey of 108 library users, revealed that only 19 (18%) had any awareness of the university's main electronic holdings. As the university was in the process of reorienting the physical space away from library books and toward study space due to overwhelming demand, this issue was of immediate concern. Printed posters promoting the material appeared to have little effect, based on informal feedback from library staff, which was confirmed by our survey results.

Library staff were keen to use QR codes to provide URLs. However, our survey also revealed that then (2012), users often did not have QR reader software on their phone (68/108) and of those that did, most reported not using it regularly (26/40) and finding the experience unrewarding (31/40). This discounted the likelihood of a QR-based approach proving helpful.

There were two recently-installed large displays that carouselled through several screens about the library. Each screen appeared for 12 seconds, and there was no way of capturing the screen, other than photographing it. We initially considered the snap-and-grab approach of Maunder et al [32]. However, that is based on Bluetooth and at the time users often had Bluetooth turned off to save battery, and the standard was unreliable. The approach of capturing the content from a large display appeared to have promise, as users did notice the displays, and over two thirds (73/108) reported seeing some material of interest, but even they had problems in following it up.

Following the survey, two prototypes were constructed using a participatory design method with a panel of two library staff and six students. A pilot-study with ten users tested both designs, and that evaluation strongly favoured one, that we now describe.

5.1 Design

The host library provided subject lists for 14 different domains (incl. business studies, music, computer science and electrical engineering). Each listed up to ten online sources, including ebook collections and, more commonly, journal databases.

The app, when used near the library's two electronic displays, allowed the user to 'capture' the current subject (e.g. electronic engineering) on display. This would open a webpage with links to the relevant subject materials (e.g. the IEEE digital library) available through the library. The links would only required the student's login to get full-text access. The subject web page would appear if the app was opened outside the library. We simply used network time to identify the currently displayed subject, and

presumed no 'capture' would occur within the first second of a page's display, without referring in fact to the previous page.

This 'portable' web-page addressed the primary problem that emerged during the design process—that users found even short URLs hard to type in. One design participant had photographed the content of slides from the existing displays, but even that did not directly solve the issue—e.g. 'typing it [a URL] in when the phone keeps blanking is a pain'. The page could also be emailed to the student's university email account, for convenience.

5.2 User Study

The prototype was tested in a three-week trial. There were 113 recorded installations of the app in the first week, followed by a further 72. All but 24 were through a pop-up information stand at the library In total, there were 93 uses of the app's capture feature. We recruited twelve participants who used the app, and conducted a brief diary study, with entry and exit interviews.

The twelve participants included seven female and five male students. Ten were undergraduates, and two graduates (both female). Each participant was asked about the digital resources available for their discipline. Only three were able to name one online resource, though ten reported being aware that there were resources (e.g. P1, 'I…ugh...I know there is stuff, just I'm not sure what there is' and P9 'I know I should have but I'm not sure I have time'. These responses reflected the experience of the library staff. Interviews covered thirty library-related questions, covering borrowing rates, times of use of the library, use of inter-library loans, etc. This was done to gather more information on the participants, while not exposing the main purpose of the study.

In their exit interviews, participants named 23 resources in total, and thirteen could name at least one resource. All had used the app at least once. All but one had used the app within four days of starting the study, and only two used it in the three days before the end of the study. Despite the obvious risk of priming from the app's function, the length of intervening period (on average just over 10 days from the last use), makes it unlikely that participants would have taken care to remember specific details.

However, it was also clear that few participants would have installed the app just to gain this information. To quote P6 'Honest, I'm not sure I'd have bothered. I try not to have too many apps.' The weak maturity of web apps at the time circumscribed the implementation, but now a web-app would be easily made. The current version includes subject-specific library information on electronic holdings which can be texted or emailed to the user.

Another issue was the role of the displays in the library. P4 noted, 'I often ignore them. The content is … I don't find it useful?' and P6 said 'You pass them, but too often they're just blank or telling you the opening hours, which… well, if you're in there, it's open?!'. This explained the limited number of installations via the displays: users had learned to ignore them. In contrast, direct recruitment produced many more installations. This ignoring of a regular feature of the space is analogous to banner-blindness in web usability [33], where users consistently ignore heading content on web pages, due to it often containing little useful information. While webpages have no physical form, expectations of place can lead to inaction, as well as action.

5.3 Summary

Superficially, this design was effective. Readers captured information on digital library offerings via their mobile phones; and then accessed those holdings outside the library—e.g. at home. The app thus expanded the library place beyond the building. The most interesting finding in terms of space and place, though, is that library users learned to ignore the library's digital displays—an element of space—to the detriment of their uptake of new books and systems, i.e. use of the library as a place. This demonstrates an interesting challenge for libraries as currently physical displays of new books are heavily used as sources of discovery [34; 35].

6 Study 3: From Print Books to Ebooks

This 2017 study addressed the problem that libraries' main textbook holdings are increasingly digital, but seldom visible in the library itself, and use is often low [36].

As noted in Study 2, one approach has been to put up signs that tell users the availability of the electronic holdings, but this has not proven effective in widespread use. We now took a different approach. Rather than highlighting the general availability of ebook collections, we focused the reader's attention on specific ebooks related to a print book they chose. We planned to use location as the key, but this proved impracticable. Instead, we allowed readers to scan barcodes of books of interest, then showed related ebooks.

6.1 Design

The host library provided two complete catalogues: first, their traditional print book holdings, and second, their main ebook collection. Both collections were uploaded into a database and indexed. Where the catalogue data allowed, the electronic form of print holdings was identified, and for electronic holdings, any print copies were noted. However, few books were held in both forms. Almost every book (over 99%), print and electronic, had one or more Dewey Decimal Classification numbers, and these were used to identify related books that shared the same topic.

We did not have access to the full text of either collection, so full-text search could not be used. Words from the book's title were used to find and rank potentially relevant documents. Some books shared no non-stop words with other books in their classification topic. In such exceptional cases a random choice of all documents was made. Normally, a random selection was taken from the top 10 ranked documents. Pilot tests led to showing three sample books to the user, as this fitted on a single screen.

We rejected the use of location within the library in this app for three reasons: 1) it was not practicable to provide the number of Bluetooth beacons needed for the whole library; 2) a low density of hubs meant WiFi could not be used for fine-grained location data; 3) Apple and Google had restricted the ability of apps to use network data to identify a user's location.

Instead, books' ISBN numbers were captured using the phone's camera. The ISBN was validated and then used to identify the (print) book being scanned, and related ebooks were found in the

database, before being presented to the reader. Clicking on an ebook would open its online page on the user's web browser.

When a reader scanned a (valid) book, the app queried the database for three best matches for display. The request and the response were logged on the server, with any selection of books by the user. The user's geolocation, if available, was also recorded.

6.2 User Study

We deployed the prototype on the personal mobile phones of seventeen volunteers who agreed to have their usage of the app tracked over two weeks. In addition, participants could indicate if the content suggested to them was useful, partly useful or not useful, and provide brief diary-like commentary after each use.

The study design was approved by the University of Melbourne Human Ethics Approval Group. No personally identifying material was recorded. The cohort contained 7 female, 10 male undergraduate students. Where two or more scans occurred within ten minutes, the scans formed a multi-scan session. Other scans were in single sessions.

6.3 Results

There were 61 logged uses of the app, though the records of 8 were incomplete due to the user dismissing the feedback step. In four of these eight cases, the scan was immediately followed by another scan. We found that 29 (14 pairs, and one set of three) scans occurred as part of a scan session (see above for definition). Thus, there were 15 multiple scan sessions, and 32 single scans.

6.3.1 Location

Nine sessions took place outside of the university. Four took place at the bookshop of another university, one at a large public library, and four at other locations that appear to be domestic. One certainly was, the diary entry simply saying 'scanned at home'. Three other sessions took place at the university bookshop, close by the library. These different sessions included 7 users—so almost half used the app outside the library, which we hadn't foreseen.

Study instructions presupposed location within the library. Without prompting, the app was used in other book-related places. It is likely that had the participants been briefed to use the app more widely, there would been more use outside the library. This shows that even in a brief deployment, users will experiment with a mobile service in locations where similar activities occur.

6.3.2 Feedback

The success of individual recommendations varied. The system made a total of 183 recommendations (three per scan), obtaining quantitative feedback on 58 items. Forty-one were rated useful, eleven partly useful, and six not useful. All but six of these items were clicked on for reading—two of each rating type. The unrated items likely contain a higher proportion of not useful and partly useful ratings. As many choices were necessarily random, this is a credible outcome, when contrasted with the selection rate for search result lists [37; 38].

Two participants, P4 and P9, both scanned the same book (on Python). They saw the same recommendation—an ebook of a Python textbook by another author. They rated the ebook highly, P9 noting 'nice to get an ebook too'. An accounting book was scanned and an alternative ebook resulted in P3 recording 'didn't know we had this—no need to carry it. Took the book too.' These responses suggest that at least three participants ended up using an ebook in addition to a text they borrowed from the library.

Four participants provided feedback that there was a missing feature in the app. To quote P3:'You can't scan a book that isn't there', and P12 noted 'wanted to scan a missing book—used another'. This points out an, in retrospect, obvious problem: absent books cannot be scanned. For context, the university has few books that are held in both digital and print form—so the feature would seldom reveal an immediate digital equivalent.

All but one of the participants reported the app as useful. This was corroborated by usage: while individual matches varied in usefulness, 49 (of 61) scans logged one or more viewed matches. and 47 scans included one or more positively rated matches.

6.4 Summary

This study revealed that even when an app is expected to be grounded in a particular space, users will rather associate it with the place's function, than location. Our users exploited the app in other reading places, not simply the intended location of use.

Engagement with the app's recommendations was good, and resulted in the discovery of new material. As with Study 1, users engaged well with book-focussed recommendations, which contrasted with the lower engagement seen with more abstract collections in Studies 1&2. Where digital places are unfamiliar, users struggle to identify a meaning and purpose to them.

7 Study 4: Connecting distant print books

The final study addresses a limitation of physical space in libraries: two books on the same topic may be shelved at distant locations, due to the vagaries of classification. Savvy readers often exploit the library's organization by browsing books nearby one of known relevance [39]. Separating related texts thus limits the opportunity for serendipitous encounters.

Documents do not have the same constraints online. Ebooks can be classified 'polyhierarchically', with the same book appearing under multiple topics. A greater quantity of related books can then appear together. The presentation of a digital library can be also re-arranged at will, e.g. to highlight recommended material. However, the digital experience has limitations: readers usually scan fewer books, lowering the chance of experiencing serendipitous encounters. We developed an iPad app to bring remote, but related, material into the user's hands.

7.1 Design

The design was of a tablet-based (iPad) application, we needed the larger display space for content. Readers photographed textbook covers, whereupon Amazon recommendations for related books would be used to find, books elsewhere in the library. The app also displayed the Amazon description of the book, its reviews, and its library shelf mark.

A first-cut design prototype was created and tested with six users in a pilot test, and initial usability issues addressed. In the

revised prototype, display functions were implemented using inVision, and the book-cover detection replicated by a wizard-of-oz method [40]. While textbook cover identification is a tractable problem, it was outside the projects' research goals.

7.2 User Study

The pilot was followed with a full study involving fourteen students in the library of a research-focussed university in London, UK. Participants were asked to browse a given set of bookshelves, select any book of interest to them, then to make use of the mobile app (to view the book's description, reviews and other recommended books available within the library). These books could be shelved anywhere in the library (i.e. all recommended books in the library were catalogued, including those not on the given set of shelves). After interacting with the prototype, and any movement across the library to examine the other books recommended by it, participants were asked about their experiences of the prototype in a semi-structured interview.

Our interest was in the overall benefit of providing a digitally unified space of related books, where the physical books were spread across the library, of bringing reviews to the shelves to inform and supplement a reader's book choices and of recommending books that may not be proximally located.

7.3 Results

Amazon recommendations influenced the readers' confidence in their book choices, unless there were already strong reasons for examining a book, such as prior experience of the book or strong recommendations by lecturers: e.g. P5 explained 'I will definitely borrow and read this book because obviously people are saying that it's not only a foundational book, but also a great book.' Seven readers rejected one or more recommendations at first glance, four on the basis of the review content being substantially irrelevant, and three on the basis of the content being generally relevant, but lacking key material that they sought.

Participants provided favourable qualitative feedback on books they would otherwise have not encountered (or rejected)—e.g. P3 took a recommended book from a bottom shelf, which they said they would normally not do. (this is a common behaviour, [19; 41]). Others reflected on the limitations of keyword search, explaining that 'I don't think I would find it without this app, because if I'm searching for books on data visualization, but the title of this book doesn't have "data" or other similar keywords' (P5). Thus, the digital place of the catalogue and the physical place of the shelves would both have negated the chances of this information encounter.

Ten participants encountered useful material from at least one recommendation. P10 commented 'I would not have searched for these four books… if I didn't have these suggestions. I would only look at the section based on the shelfmark and look at books around it'. P4, who rejected three of their four recommendations, said of the fourth 'I wasn't expecting that. I wasn't looking for it. It's relevant to what I'm looking for. It was so good and has everything I wanted. …. I'm happy with the content'.

Participants appreciated being shown the location of recommended books. P6 said 'it's giving me location, which is good because I could explore books based on proximity [to each other].'

7.4 Summary

Temporarily using digital space, to harness information not available in the physical space (in this case Amazon reviews and recommendations) successfully encouraged participants to examine books they might not otherwise have looked at. This is likely due to the fact the prototype app shifted the focus back to the physical space, by guiding participants to the recommended or reviewed books on the library shelves. We consider this an example of blending the physical and digital library spaces in a complementary way that may encourage physical library use.

As with our first study, we found that users' decisions to pursue a recommendation was influenced by perceived topic relevance and the distance within the library to fetch a book. However, the presence of the digital place within their interaction was much more successful than with the use of digital collections, as seen in Study 2. Participants leveraged their knowledge of the library as place, helping them make book selection judgments. As the entire interaction with content continued in one place, the library, there was no need to grasp an understanding of a second place, and all interaction was with physical books.

8 Overall Insights

As noted in the introduction, the idea of the library as a rehearsed place that is well understood by users is widely accepted. We've deployed four mobile systems that leverage the library space in different ways. The variable results of our investigations shed some light on the ways in which space and place affect interactions—positively and negatively—dependent on context.

The existence of banner blindness on web pages is well known [33]. We have not encountered previous literature that raises a similar expectation with space. We saw that users learn to ignore content in a space that they frequently use, where the place is repeatedly used for content of little relevance to them.

There were also problems in introducing new collections of digital material—users struggled to connect their general library knowledge of place to digital venues where scope and structure were unclear, adding considerably to their cognitive effort.

These two negative points contrast with the success we have had with book-focussed enhancements—users would use book-focussed apps in reading places beyond the library, and happily adopted book-focussed mobile services. Congruence with the utility of the place, and its content, led to effective interactions.

Similarly, allowing the user to craft a personal signal of place, through the contents of their desk, proved highly effective, particularly as the user controlled this cue.

9 Discussion

Previous researchers have endeavoured to use physical space as a lever to assist in information interaction [18; 31; 42]. These met with mixed results. There were no clear signs across that work of how space or place influenced the success or failure of these

systems. This earlier work, however, did not assess the influence of space and place on their effectiveness. Our own research suggests that relative success and failure are not simply ascribed to the physicality of the interaction, or well-established issues in information interaction.

Previous information interaction research has suggested incongruity with place is a barrier to adoption. In [42] users rejected a new library interface as being "gimmicky"—e.g. one saying 'I don't want to play some games' (in the library). Participants suggested that the new interface, which was seen as 'playful' should only be in a children's library. The disjunct between these users' concept of the library as place, and the presentation offered in this app resulted in user rejection.

Those who have argued for the use of space and place in HCI and CSCW have produced guidance on how they can explain the effectiveness of existing designs, and might be leveraged to develop new, effective interactions. However, one major caveat regarding that guidance is that much of it dates to before the mass adoption of mobile technologies (e.g. the classic Harrison and Dourish paper [1] dates from 1996), and even the later revision [4] arrived a year before the release of the first iPhone and the arrival of the mass-market smartphone. That event disrupted much of the experiences with earlier mobile phones, and no major reflection on the concepts of space and place has been offered since. While mobile technologies might seem incongruous with libraries, a number of previous studies have noted their ubiquity in library settings [23; 43; 44]; the sense of appropriate use of mobiles in the library has changed, but it met initial resistance. As with the playful interface that users resisted, the introduction of new technologies is disruptive, and the sense and use of place is defended by library readers [42]. The importance of place-consistency is by far the most relevant concept [1] from early place work.

Brown and Perry emphasised the problems of place. In contrast, we demonstrate the advantages of place-knowledge. Users appropriated a library-focussed tool to use in book-related places in general, and were quickly able to use place-based knowledge to make information about new electronic books and unseen print books. Setting a place-based frame for design is quite likely useful in designing mobile apps, and may indeed explain the relative success of interactive navigation [45], where a little local knowledge may be boosting user performance in ways we don't currently grasp. Likewise, it may be playing a key role in the demand for, and effectiveness of, guidance and explanation on interpreting local landmarks [45; 46]. Local guides are a foundational interest in mobile HCI [47], and it is surprising that we lack research that examines their utility from a place-based perspective.

Libraries represent a specifically organised and structured physical location, but other buildings share similar properties–most directly museums, for example. We would expect our initial insights into how place impacts on usability to recur in such cases, and further work to explore that is certainly needed.

Designers should consider space and place carefully when designing mobile experiences, reflecting on our existing assumptions and preconceptions to design experiences that combine the best of both the physical environment and digital technologies. Just as it is naïve to assume that we should try to digitally recreate aspects of the physical library, and vice-versa, it is also over-simplistic to consider space and place as combined concepts; we should instead unbundle them and consider how to support different combinations of space and place in a particular work or everyday-life context (in this case the library as an effective learning environment). Reflecting on how we can 'add value' by augmenting the physical environment through mobile design is important. We need to engage with design not just for the sake of novelty, but also for the sake of usefulness—and the sort of reflection we encourage hopes to engender the next generation of truly useful mobile tools, in libraries and elsewhere.

10 Conclusions

The library is a well-rehearsed place, with a range of meanings to users. The space is more contested, with study spaces competing for space with books, and silent spaces competing with social spaces. The rehearsed uses of the space—for example browsing the shelves—limit possible uses of the full offerings of the library, both in terms of the limitations of the physical space for presenting polyhierarchical information, and in terms of the massively increasing online offerings of the library.

This paper presented four systems that each leverage the space of the library to afford further interactions with the library as place. Some interventions were more successful than others: e.g. inferring too much about a reader's interest from their location, was not always successful, but examining the information place they had built for themselves was more likely to meet their needs.

Merging the digital with physical spaces was especially valuable to readers. Once the utility of these systems was grasped, they used them to expand the place of the library beyond its walls: we recorded a number of uses of systems outside the library. Equally, supporting the information available at the shelves with digital information about other offerings and recommendations and ratings improved the utility of the space.

Perhaps the most astonishing finding though, was the discovery of physical 'banner blindness' to the digital displays in the library. This (lack of) interaction with physical space revealed a surprising analogue between physical and digital space.

Overall, though, we have demonstrated a number of ways in which digital information interactions can support users of a physical space in expanding the rehearsed place of the library. These interactions afford a number of opportunities for increased access to information, and better information decision making.

There is further scope in information interaction for leveraging space to support place, particularly, we suspect, in GLAM institutions. How best to identify these opportunities and offer interesting and relevant information to meet a user's space and place remains an avenue for future work.

ACKNOWLEDGMENTS

We thank the Joint Information Systems Council and the Australian Research Council each for the support of part of this work, and our various participants for their time and enthusiasm.

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