Open spaces, mobile learning: findings from the iBorrow project

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Introduction

Augustine House was one of the most important building programmes in Canterbury Christ Church University's history. The purpose was to create and develop a large state of the art library and student support centre that offered innovative, technology-rich facilities for staff and students to use. An important feature of Augustine House was the creation of flexible recreational and learning spaces that would allow students to learn, work and relax in a manner and place of their choosing.

The iBorrow project was part of the second phase of the Joint Information Systems Committee's institutional innovation programme. The aim of the project was to create a laptop loan service that was entirely self-service and that should be no more complicated than borrowing a book. Radio-frequency identification (RFID) tags were placed inside iBorrow notebooks in the anticipation that the geo-location tracking data overlaid with additional information would provide a better understanding on how students use the digital and electronic resources available to them as individuals or within groups.

Background

During 2008–09, Canterbury Christ Church University (CCCU) undertook one of the most important building programmes in its history. The purpose was to create and develop a large "state of the art" library and student support centre that offered innovative, technology-rich facilities for staff and student to use. Moreover, it needed to be able to support over 16,700 students and 1,800 staff from across five faculties (Arts & Humanities; Business & Management; Education; Health & Social Care; and Social & Applied Sciences) with a portfolio of over 1,000 academic and professional undergraduate and postgraduate programmes.

It was against a background of rapid expansion that the library on CCCU's main Canterbury campus was struggling to meet student demand. Furthermore, CCCU's library was an area that had been identified and subject to criticism in the National Student Survey (NSS). The university knew that it needed to improve its library and information provision if it was able to meet the needs of its diverse student body at the beginning of the 21st century.

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The building – Augustine House – opened on schedule for the start of term in September 2009. It covered over 12,000m2 of space including the library and student services centre. An important feature of Augustine House was the creation of flexible recreational and learning spaces that would allow students to learn, work and relax in a manner and place of their choosing – these spaces included: enclosed study rooms, semi-enclosed group areas, open lounge areas, corridors, bridges, quiet reflective areas, cafes, indoor/outdoor terraces and a 500 seat flat floor space.

As part of the design process, CCCU was keen to provide as much mobile technology as possible in addition to its fixed desktop PC offering to facilitate these activities.

Easier than borrowing a book

CCCU wanted to develop a laptop loan service that was entirely self-service with little or no administrative and operational overheads. In other words, borrowing a laptop to use within Augustine House should be no more complicated than borrowing a book. This meant that the laptops had to be well built and the system and software secure and reliable so that the devices would always work. The plan was to combine a thin-client laptop with Microsoft's application virtualization (App-V) technologies to create a robust, sustainable and flexible system.

Thus the iBorrow project was born. This was one of thirty-nine projects that formed part of the second phase of the Joint Information Systems Committee's (JISC) Institutional Innovation Programme (IIP). The project was funded by JISC and match-funded by CCCU and involved the deployment of 200 Asus 1000 thin-client (atom-based processor) notebooks for students and staff to borrow and use within Augustine House. Given the timing of the project (2008–09), Windows 7 was not available to the project team, so a lean version of the Windows XP operating system was installed (since August 2010, all 200 iBorrow notebooks have been upgraded to Windows 7). The notebooks made use of the eduroam Wi-Fi service that would allow them to connect to Microsoft's terminal services so that App-V could remotely deliver desktop software to the user. Users of the iBorrow notebooks had access to the Microsoft office suite, Internet and e-mail connectivity and library services, as well as being able to connect to their network profile – in short, students and staff had an 'equivalent' computer user experience to that of fixed desktop PC users.

In addition to the software described above, the iBorrow notebooks had radio-frequency identification (RFID) tags placed inside them. It became apparent during the design process of the project that there was little or no empirical data on how students use learning spaces and how these need to be configured. It was here that the project team felt that the use of the latest geo-location tracking technologies would enable them to collect significant amounts of data that could inform future learning space design and development. Moreover, the use of geo-location tracking data overlaid with additional information could support a better

understanding on how students might use the digital and electronic resources available to them as individuals or within groups.

The project also afforded the team with an opportunity to understand how students might use mobile against fixed computing devices within large-scale flexible learning spaces. More importantly for the HE sector, the project provided an opportunity to demonstrate how an institution might go about implementing software and desktop virtualisation and deploying these across a wireless network. This touches upon the green ICT and low carbon agendas for a number of reasons:

● The use of solid-state drives (SSD) instead of hard drives reduces power consumption, as there are no moving parts with SSDs.
● With the iBorrow notebooks connecting via a terminal server, all the computing power is carried out by the server rather than the notebook which sees a reduction in terms of energy costs and consumption.
● As the university has five campuses spread out across Kent, application virtualisation enables applications to be dynamically delivered to desktop PCs and iBorrow notebooks thus reducing the amount of time and travelling IT staff would be required to do in order to maintain and upgrade computer software.

Benchmarking data

The JISC Evaluating Learning Spaces (JELS) report highlighted that institutions needed 'to develop baseline information to inform the design of future new space projects' (JELS 2009, 6). With this in mind, the researchers conducted a range of research activities relating to the old university library. These activities took place between April and July 2009. The research was opportunistic in so far as that the resources available to them were limited and so surveys and observations had to be carried out when human resources (members of staff and student volunteers) were available. The timing of research was largely dictated by the removal of some staff from the library building and the decommissioning of the old university library in April 2009, as part of a much wider redevelopment programme taking place on the main university campus. However, despite these challenges, the researchers were able to collect some benchmark data for comparison with the activities that would eventually be taking place within Augustine House. The benchmark data was gathered through the following methods:

● Observations of students using the old university library
● A student survey (n: 275)
● An online survey for academic staff (n: 80)
● Interviews with key stakeholders who would be relocated and working within Augustine House. (n: 14)

A more detailed account of the research processes and findings can be found in Dr Lynne Graham-Matheson's report (Graham-Matheson, 2009). It is interesting, however, to note that of the 275 students surveyed, 77% of them said that they would use an iBorrow notebook if it were available at the time.

Post-occupancy data

Augustine House opened its doors to students and staff in late September 2009. The post-occupancy data was gathered through the following methods:

- Observations of students using Augustine House (pre-iBorrow deployment)
- Observations of students using Augustine House (post-iBorrow deployment)
- Student interviews (n: 174)
- Facebook 'vox pop'
- A follow-up online survey for academic staff
- Geo-location tracking of iBorrow notebooks.

It was fortuitous that the iBorrow notebooks were not available to use when Augustine House was opened, as the researchers were able to carry out a week long observation study on how the students were engaging and reacting to Augustine House and its facilities without the iBorrow notebooks being present. The study wanted to look at students' use of the building and that of fixed desktop PCs or their own laptops within the various flexible learning spaces. It was noted that there was peak activity within the building for a few hours around midday; much of this activity was dictated by the availability of fixed desktop PCs and it would seem that students favoured particular areas of the building, such as the enclosed study rooms and the quiet reflective areas. This activity provided the team with some crucial benchmarking information to compare against once the iBorrow notebooks were available to use.

In early November 2009, the iBorrow notebooks were ready to use and the researchers repeated their week long observation study on how the students were using the full range of IT facilities, or their own laptops, within the different spaces. Again, it was noted that much of the peak activity centred on the few hours around midday. Whilst it was clear from observations that students were still making use of the fixed desktop PCs, the iBorrow notebooks were also in heavy use. More importantly, the students were making far greater use of the different recreational and learning spaces that were available to them. The flexibility and portability of the wireless notebook computers meant that they were able to occupy different spaces of students' choosing in a range of working, studying and recreational configurations such as being on their own, with a group of friends or peers.

The students who agreed to be interviewed (n: 174) represented a wide range of academic and professional programmes across the five faculties and were found to be spread out across all four floors within Augustine House in a range of configurations – on their own, in pairs, in triads or in groups – and working in different locations, ranging from the enclosed study rooms to the open lounge areas. From the interviews, 58% of them commented on the iBorrow notebooks being 'good for group work', whilst 98%

valued the iBorrow notebooks 'flexibility'. Indeed, one music student in her third year commented that the 'technological facilities are a real asset and a vast improvement'.

The most common group configurations were either a combination of iBorrow notebooks and students' own laptops, or one or more students using the fixed desktop PCs, with friends opting to use an iBorrow notebook so that they could sit together, rather than looking for another fixed desktop PC elsewhere in the building. However, it was made clear by the students that if they had to engage in tasks and activities that required some careful dexterity (e.g. manipulation of different media forms) or prolong periods of reading and writing materials on screen, then the fixed desktop PCs was preferred over the iBorrow notebooks for more 'serious work'.

During these interviews, students were also canvassed on their use of the iBorrow notebooks. The following activities represent how they chose to use the devices:

● 28% used Microsoft Word (for written assignments)
● 25% used the Internet for research
● 14% accessed some form of social networking site (e.g. Facebook)
● 13% checked their e-mail
● 9% used Microsoft PowerPoint (for presentations)
● 7% engaged in course-assigned work
● 2% logged into Blackboard (CCCU's virtual learning environment (VLE))
● 2% wanted to send documents to the printer.

Whilst there is clearly some recreational use (i.e. social networking) of the iBorrow notebooks amongst the student body – which, incidentally, was much lower than was originally anticipated – most of the iBorrow usage is centred on working and studying. The students have enjoyed the portability that the iBorrow notebooks offer in terms of sitting together in any available space whilst working on different aspects of a group assignment. They have been able to take the notebooks with them whilst looking for books, journals and other resources so that they can either make some rough notes using Microsoft Word or to double-check that they are using the appropriate resources by checking the course material that is available to them on the VLE. Meanwhile, others within the group can be working on the bare bones of a presentation that they will eventually give to their tutor and peers.

Finding the digital needle in a virtual haystack

In addition to the more traditional research methodologies of observational studies and interviews, another aspect of the research project centred on the geo-location tracking of the iBorrow notebooks and their relation to the space within Augustine House. Each of the 200 iBorrow notebooks had RFID tags placed inside them, thus providing spatial and temporal information. Once a student logged into the university

network via the iBorrow notebook, additional information was also collected about them in terms of age, gender and course information. The various sources of information were aggregated, collated and then finally filtered so that the researchers only had access to completely anonymised data that was in accordance to the project's ethical and legal obligations (e.g. Data Protection Act). Table 1 below represents the type of data that was being collected. The inclusion of the user session ID is only valid for up to 24 hours and is bound to a particular user session; this came in response to an issue involved in the cumbersome nature of compiling the information from the data set. It meant that unique identifiers were now attached to a user profile without revealing the identity of the student. A consequence of the ephemeral nature of the user session ID meant that the team would be unable to determine whether the same student logged in again during that particular day or in any subsequent days. Staff and associates who used the iBorrow notebooks were not tracked as their log in details were used to exclude them from the data set. Students who used the wireless network for connecting up their own laptops or personal mobile devices within Augustine House were not tracked and any information about them was not available to the researchers.

Table 1 A representation of the type of data collected

Variable name	Example of data
User Session ID	USER201029090018 [USER+year+month+day+4 digit counter]
Location zone	W1B, E3C, etc.
Time stamp	29/9/2010 14:34
Level of study	Undergraduate or Postgraduate
Type of undergraduate degree	Single or Combined
Subjects studied	Major and minor subjects
Year of undergraduate study	1, 2, 3, etc.
Age	22
Disability	Yes or No, (but not details of disability)
Gender	Female or Male
Mode of attendance	Full-time, Part-time, etc.
Postcode of student residence	CT1, ME1, TN1, etc. (but only the first half of the postcode)
Campus where student is based	Broadstairs, Canterbury, Folkestone, Medway or Salomons

Geo-location tracking data was captured in five minute intervals so that it was possible to record the students' movements with the iBorrow notebooks in fine detail. It was estimated that if all 200 iBorrow notebooks were being used at the same time, it could potentially generate up to 57,600 records per day.

The data that was being collected gave a rich picture of the iBorrow demographic and it was clear that the students (from across the five faculties) were using the notebooks in different locations within Augustine House. It would seem that the gender ratio within Augustine House was similar to that of the university's Canterbury campus – with females being represented by 3:2. The ages of the iBorrow users and the Canterbury-based students were also similar in nature, with 18–24 year olds representing the dominant group. As confirmed by the second Augustine House observation study (post-iBorrow deployment), it was clear from the geo-location tracking data that the students preferred to work in the open lounge areas within the building. Here, the furniture and space can be reconfigured and personalised to meet the students' needs and the mobile dividers that are present can be used to provide some level of privacy. Moreover, the open lounge areas are located at the front of the building, which overlooks the medieval city walls and historic gardens and park, providing an attractive backdrop for workers and visitors to Augustine House.

The learning landscape – now in 3D

Given the vast quantity of data that was being recorded by the geo-location tracking system, the researchers sought tools to help visualise and make sense of the data that was being collected. CCCU went into partnership with the weCAMP team, another JISC IIP project based at the University of Sheffield, who were developing a 'web-based 3D interactive visualisation modelling platform called uCampus' to assist with 'collaborative planning and design of future learning spaces'. The weCAMP team were given the architectural plans of Augustine House so that they could build a 3D model of the building complete with furniture and other assets.
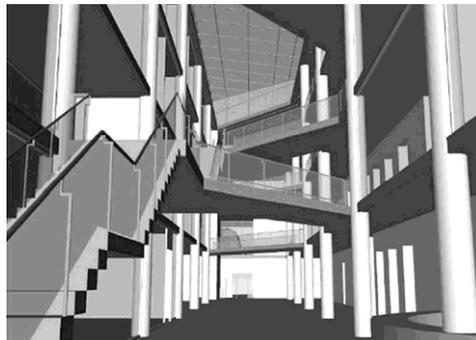
Figure 1 Augustine House – exterior 3D view   **Figure 2** Augustine House – interior ground floor 3D view

The weCAMP team were also given a week's worth of data, incorporating the X and Y co-ordinates, on an Excel spread sheet that would be overlaid onto the 3D model of Augustine House so that the iBorrow team could see how the space was being occupied over time. The 3D model would provide a rich and powerful means for visually representing very large and complex data sets. Dr Chengzhi Peng provides a very

thorough account (Peng, 2010) of the issues in bringing this project to life and the challenges in mapping the dataset onto the 3D model, as well as some examples of how the data is visually represented against criteria like age, gender and level of study. He concludes that this 3D mapping exercise "has shown a possible route to future work on the data fl ow and system integration that will deliver a very powerful platform for undertaking interdisciplinary empirical researches to large-scale learning and other types of spaces which were not possible before." (Peng ,2010).

The learner's footprint

The other tool that was developed made use of a Microsoft Access database to generate a number of 'views' or 'snapshots' of the core dataset (which was held on a Microsoft SQL server). A series of algorithms were created to depict 'popular day', 'popular time', 'popular location' for a given week or month. The most 'popular day' for many of the students was a Tuesday with 2pm being the most 'popular time'. The most 'popular location' turned out to be the ground fl oor lounge area – which is not surprising as this was the only area within the building that was open to students after 9pm (until 2am) when the rest of the building was locked up; so in many ways this rather skewed the outcome of the location results. The researchers also used the tableau desktop software to enable them to visually analyse the kind of spaces that the students were particularly attracted to. From the visual data, it could be seen that the students tended to be drawn towards either the open lounge areas or the enclosed study rooms. A number of conclusions could be drawn from this:

● Students like the informality of the open spaces and the ability to personalise a space just by rearranging the furniture.
● Students appreciated the privacy and quietness that the enclosed study rooms offer them especially during group-related work and tasks.
● The popularity of the enclosed study rooms meant that other students had to make their own group areas within the open spaces.

However, the database provided something much more compelling – the 'learner's footprint'. For a given day, the researchers were able to view the 'learner's footprint' by looking at when a particular user session began and when it ended. This was calculated to give the length of time that the student had spent logged onto an iBorrow notebook. The total number of locations that the 'learner' visited during that session was also recorded, thus providing a very quick snapshot of the length of stay by the students and their movements within the building.

Furthermore, the database enabled the researchers to drill down into some detail by selecting a particular student's user session ID and examining some demographic and course information about them (as exemplifi ed in Figure 3) as well as their 'footprint' within the building during that period and how long they

had occupied a particular location. This begins to illustrate something of the learner's behaviour within a large-scale flexible learning space and the kinds of resources and assets that they need to access in order to support their studies. It is interesting to note that there were examples of students (or rather their iBorrow notebooks) spending up to three hours in just one location; others spending over five hours but
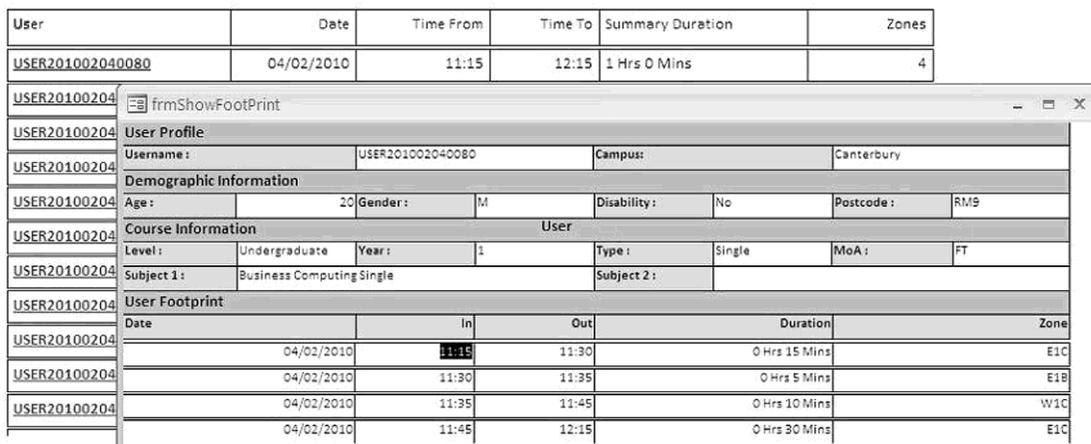
Figure 3 Screenshot of the 'learner footprint'

moving around with their notebooks within a wing of the building (such as going back and forth looking for books and journals on the shelves); other students were recorded as moving between wings on the same floor or even traversing between floors (perhaps to pick up a coffee or a bite to eat in between work and studying; or to find friends or peers). In some instances, there were a number of students who were working in spaces where the resources that you would expect them to use were located on completely different floors – this could suggest a number of things:

● The resources that they needed were available electronically
● They used the notebooks for non-learning tasks and activities
● They wanted to be closer to friends (as suggested in the student interviews)
● As this was a new building – it had just been opened for two months before the recording and collection of the tracking data – the students had yet to develop a 'mental map' of where they could locate the resources that they needed
● Certain floors or spaces may be more comforting or reassuring, psychologically, than others.

The tutor experience

Much of the iBorrow project focused on the development and deployment of the technology and that of the student experience. Whilst the researchers were keen to see how tutors responded to Augustine House and the facilities that it had to offer, some academic staff were not able to engage with the building as much

as they would have liked. The building did not open until the start of the 2009–2010 academic year which meant staff did not get to 'see and feel' the building beforehand and consequently were not able to plan for its inclusion into their teaching activities well in advance. As the building is situated in the heart of the City of Canterbury, some staff expressed a reluctance to make the 10-minute walk between the main Canterbury campus and Augustine House across a very busy and dense thoroughfare.

However, for more confident, creative and enterprising tutors, Augustine House presented an opportunity to explore and exploit the space and resources to develop different approaches to teaching practice. Some would plan their teaching around visiting Augustine House for a few hours; in some cases this would include lunch, and they would organise activities around research (both paper and digital), discussion groups, tutorials and facilitating group projects. A few examples of these have been taken from Graham-Matheson's (2009) report by way of illustration:

● PGCE students are directed to use the curriculum resources area for a task that has been set for them by their tutors. Whilst working in Augustine House, they take time to have lunch and to meet with their tutors to discuss their learning journals.
● Students in parallel teaching groups are set a collaborative task to work within groups in Augustine House. Their tutors determine the groups so that students have the opportunity to work with fellow students they have not met before.
● Students spend the day working in the building to prepare for a group presentation using the interactive whiteboards, video, etc. and then present their work and findings to the other groups within their course at the end of the day.

Conclusion

The iBorrow project presented CCCU with an enormous undertaking and a challenging exercise to demonstrate the practicalities and benefits of deploying thin-client, wireless mobile devices within large-scale flexible learning spaces in the higher education sector. The project was successfully able to illustrate the benefi ts to students and provide them with the opportunity to choose how, when and where to work and learn either individually or in ad-hoc groups. The pioneering nature of the project meant that it had to be managed carefully in terms of its ethical and legal obligations as well as its technical ambitions. The initial analysis of the geo-location data has provided proof-of-concept of the range of possibilities and opportunities for educationalists and learning professionals in developing new insights to explain learner behaviour using mobile technology within this kind of learning environment.

Given the project's scale and scope, it was awarded the 2009 UCISA Award for Excellence in which the judges noted that 'the project met a clear business need by providing access to laptop technology to a

university population where laptop ownership is not common'. The project was also short listed in the Times Higher Education Leadership and Management 2010 awards in the category of ICT Initiative of the Year.

References

Graham-Matheson, L. (2009). iBorrow Pedagogic Research Report. Canterbury: CCCU. Available at: **www.canterbury.ac.uk/projects/iborrow/documents/iBorrow-Pedagogic-Research-Report.pdf** (Accessed 27 September 2010).

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Peng, C. (2010) The Augustine House Experiment: Final Report. Sheffield: University of Sheffield. Available at: **www.wecamp.group.shef.ac.uk/AHE/JISC_AHE_Final_Report.pdf** (Accessed 7 January 2011).

Useful links

Augustine House: **www.canterbury.ac.uk/augustine-house/**
iBorrow Project: **www.canterbury.ac.uk/iborrow/**
weCAMP Project (Augustine House Experiment): **www.wecamp.group.shef.ac.uk/AHE/**