Student Study Space Finder Interface Assignment 3

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Introduction

The Study Space Finder project seeks to assist the Library Services department of the University of St Andrews in their mission to support the academic endeavors of the University's students and staff. As the student population at the University grows, Library Services are actively engaged in discovering new ways to serve the needs of the increasing number of library patrons. Though the library has provided solutions to accommodate the increased demand in the form of improved facilities and additional study space, communicating those solutions to their patrons has been a challenge. To that end, the Study Space Finder project and its resulting prototypes are intended to help Library Services communicate the many options available to their patrons as they search for suitable places to pursue their academic endeavors.

This report will restate the needs of the client as they were presented at the beginning of the project. It will then outline the goals of the project as determined by the project's student team. The solutions recommended by the project team and the rationale upon which they are based will then be explored. Finally, the report will outline the different paths and decisions explored by the team during the research and design process.

Concept Statement

The following concept statement was provided by Ewan McCubbin, Assistant Director of Library Services (Public Services & Communications):

The University Library service has seen significant improvements in recent years. We have invested heavily in digital and print collections, have world-class special collections and take pride in the quality of customer service our staff provide to students. In 2017 our frontline teams became the first part of the University to achieve the UK government award of Customer Service Excellence.

However, where we do face challenges is in meeting demand for and coping with the pressure on study space, particularly in relation to the Main Library. Built in 1976 for a student body of 3,500, the Main Library is unusual compared to many other UK universities in that

it has never been physically increased in size. It remains the largest single study space facility in the University, with over 1,000 seats across its 3 levels.

Now serving a student body of over 9,000, the building sees average daily footfalls during semester in the region of 6,000-7,000 visits and regular problems symptomatic of overcrowding, such as seat hogging and queues for toilets. Comparative data shows that our library spaces are the second most intensively used in the UK university sector per full time equivalent student. Whilst National Student Survey and PG Experience Survey scores in relation to the Library have improved in recent years, students still regularly complain about availability and quality of university study space.

In 2011/12 a £7m redevelopment project was carried out which improved the number and range of study seats and added technology such as our access gates which have allowed us to increase opening hours and provide students with access to current occupancy information. A further £3m development is planned once the current sub-basement (Level 1) is vacated of our general collections store and staff accommodation, all of which will move to the new Eden Campus at Guardbridge. This will allow for the creation of an additional 375 study spaces including a PG-specific study zone, but not until late 2020.

The University Library service manages a number of different facilities and of course others exist, independent of the Library's administration but information about space is patchy and facilities are sometimes only provided at certain times or to certain students. In the absence of clear and meaningful information, confusion and misinformation arises (such as the graduating student who didn't know the King James Library existed or another student who thought Butts Wynd PC lab was only available to Computer Science students).

The Library service wishes to improve the student experience by commissioning a tool that will provide the following:

- *A tool that will describe and help students find different types of study space.*
- *The information available through the tool should be accessible and editable by staff*
- *Address the actual needs of students who need study spaces.*

Goal Statement

The initial issues were outlined through the Concept Statement provided by the client. This statement details several challenges faced by the capacity of the University's libraries, especially the main library. The client highlighted these issues and gave us considerable insight throughout the project in fortnightly meetings. This helped us to refine and improve our understanding of the problems they face and further the goals of the project.

The understanding gained from our primary and secondary research undertaken assisted the definition of specific criteria required from users that are utilised in the project through filters, features and information throughout.

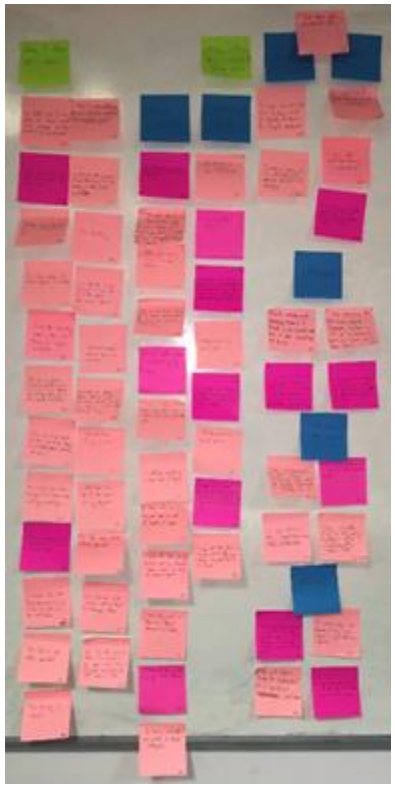


Figure 1 -- Subsection of the Work Activity Affinity Diagram

The main goals were developed utilising our sketching ideation process and contextual inquiry to develop key aspects to focus our overall process on:

- Help students locate the best available study space for their current needs
- Allow students to save information for later access
- Function on a variety of devices
- Provide guidance quickly and easily
- Allow easy, low cost modification and maintenance

The resulting tool is designed to facilitate locating study space that best suits students' individual needs and reduces the pressure on the main library.

Final Proposed Designs

Throughout the process of designing the Study Space Finder we have focused on the K.I.S.S. principle (Keep It Simple, Stupid). To this end we have concentrated on solutions that provide the most useful information in the easiest to use format. This has informed our decisions throughout the course of contextual inquiry, sketching, and prototyping the product.

Contextual Inquiry

The process for deriving the final prototypes began with an extensive contextual inquiry. We initiated the inquiry by meeting with our clients from Library Services, with whom we discussed the University's needs and defined the scope of the project. We then conducted interviews and observations of students currently matriculated at the University of St Andrews to better understand how they find places to study and which aspects of a study space they most value. The information from the meeting, interviews and observations was distilled into 305 work activity notes. Analysis of these notes allowed us to build models of the students' behaviour, needs and desires. These models, including a Work Activity Affinity diagram (Figure 1), a Flow Model (see Appendix A), and two Hierarchical Task Models (see Appendix B), became vital guides in our production of user requirements and the resulting sketches and prototypes.

User Requirements

Our contextual inquiry process led to the development of fifteen key user requirements (see Appendix C). Each requirement was derived from the work activity notes that were used to construct the Work Activity Affinity Diagram; every user requirement is linked to the relevant work activity notes from which it was derived. By maintaining the path from the stated or observed needs of the participating students to the features and functionality described in the user requirements, we are able to assure that the issues we identified during the contextual inquiry are addressed in the resulting product.

Sketches

Our goal in creating sketches was not to define a solution, but to probe the problems students face when finding study spaces and to explore a broad tableau of possible answers.

Figure 2 -- Problem Scenario Sketch

To this end, a substantial number of sketches were produced with one of two goals in mind: defining the problem or investigating solutions. Figure 2, for example, illustrates a problem sketch that was used to explore the difficulties in finding accurate information about available study spaces in the Main Library. By producing a variety of sketches, we were able to discuss the issues and visualize potential solutions with agility and minimal overhead. These sketches and the ideas they captured were used in the subsequent phases of prototyping and in discussions with the client.

Initial Prototypes

As a team, we developed several prototypes at varying levels of fidelity. The initial prototypes consisted of white board sketches, which were chosen for their ease of creation and open, collaborative nature (see Figures 3 and 4). These prototypes were created as a group and everyone participated by drawing ideas and discussing their merits. These low-fidelity prototypes differed in nature from the sketches as they began the actual design process for the product that would be delivered to the client.

Having discussed the initial designs of the prototype, the team next developed paper prototypes (Figure 5 through 7) to represent various possible screens and user journeys. Again, the choice of lower fidelity prototypes allowed us to easily change the designs and rapidly produce possible solutions. Though sketched in a similar fashion to the whiteboard prototypes, the paper prototypes allowed us to capture finer details and visualize the product in a form factor similar to that of a mobile phone screen. These prototypes also helped us permanently record ideas that could later be referenced as we developed our high-fidelity final prototype.

Figure 3 -- Whiteboard Prototype of Product Screens

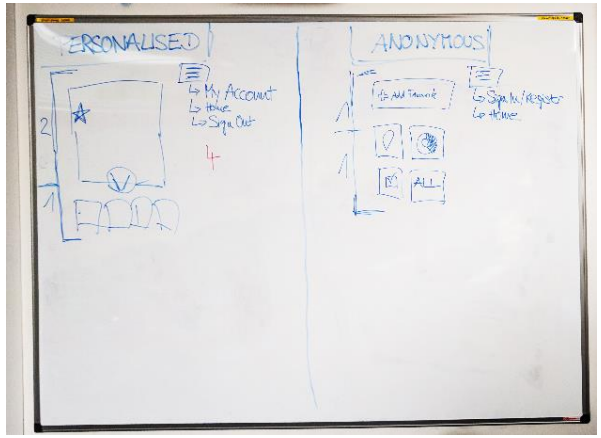


Figure 4 -- Whiteboard Prototype of Screen Layouts

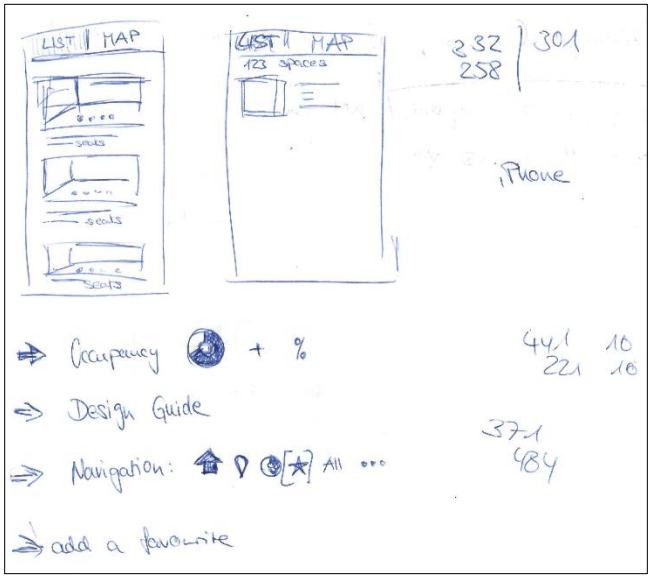


Figure 5 -- Paper Prototype Reserved Seating

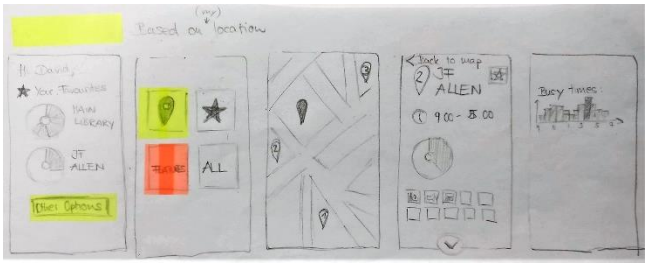


Figure 6 -- Paper Prototype Location View

Figure 7 -- Paper Prototype Favourites View

Final Prototypes

After exploring ideas and options through our low-fidelity prototypes, we determined that we had accumulated enough information to invest time in carefully-crafted, high-fidelity prototypes. These prototypes were created using the online prototyping tool Moqups. The choice to create high fidelity prototypes was motivated by the desire to define not only the look and feel of the product, but also the user's experience as they interact with the tool. Therefore, the choice to create mock-ups using the Moqups tool was motivated by several factors. First, the tool allowed the creation of prototypes using simple drag and drop tools, which reduced the time required to learn and use the product. Second, it also facilitated collaborative work, as all the team members could work on the prototypes simultaneously and from different locations. Third, it allowed us to not only design the product's screens, but also a simulated experience of what might happen as a user interacts with the product. Finally, and perhaps most importantly, Moqups allowed us to easily communicate within the team. The tool enabled us to discuss questions and ideas by providing a commenting feature that allowed us to flag specific screens or elements and insert comments directly into the prototype. By taking advantage of this mechanism we could continue to discuss the development of the prototype as a group between our regular meetings and calls.

We developed three final prototypes that will be provided to the client. One prototype is a conservative mobile-first system that fulfils the user requirements in a clean, simple to use format. The next prototype is an extension of the conservative prototype, but with an experience better suited to large screen displays, such as what might be encountered on a tablet or computer. The final prototype is an out-of-the-box interpretation of the requirements and is provided to give the clients another possible option that eschews a more pedestrian approach. It also explores options that may not be possible given current technological, political or budgetary constraints, but might provide ideas for future extension of the system. Each of the three prototypes will be illustrated in the sections below.

Conservative Mobile Prototype

The conservative prototype is based on a mobile-first web application. Static images of this—and subsequent—prototypes have been included above, but a fully-functional interactive prototype is also available here. The goal is to provide the most relevant information to users with the minimum amount of effort required. We hope to help users locate the best study space for their needs quickly, so they can focus their efforts on studying and not on using the product.

There are two experiences a user might encounter when first accessing the Study Space Finder on a mobile device, depending upon whether they have created and logged in to an account (the personalised experience) or not (the anonymous experience). Figure 8 displays the Study Space Finder's home screen for an anonymous user on a mobile device.

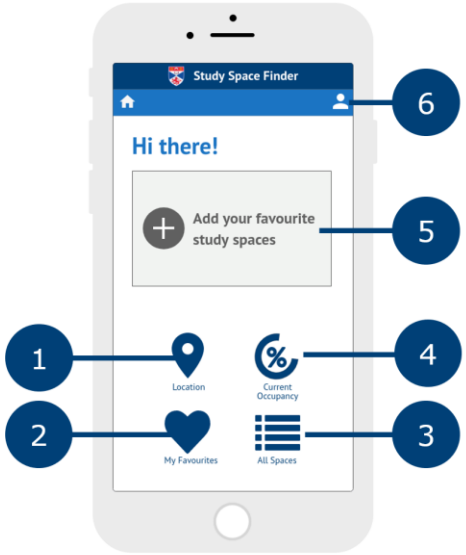


Figure 8 – Home Screen, Anonymous

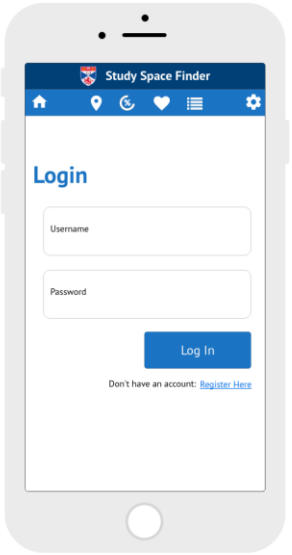


Figure 9 -- Login Page

This page allows the user to quickly select their preferred method of finding study spaces by presenting four large icons: (1) Location Filter, (2) My Favourites, (3) Occupancy Filter, and (4) All Spaces. Additionally there is an "Add your favourite study spaces" call to action (5) that, if selected, will redirect the user to a login (Figure 9) page, with an option to register for an account (Figure 10).

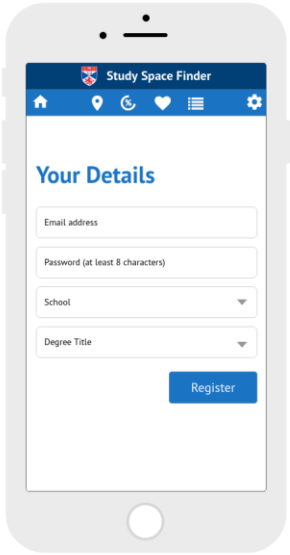


Figure 10 -- Registration Page

Users can then create or log in to their account, after which they can add favorite study spaces that will display on the homepage. The My Favourites button will produce the same experience as the call to action. Additionally, if users are not logged in they can select the user account icon (6), which will load the login page and registration page, as described above. Of particular note are the options on the Registration page that allow the user to select their school and degree. By providing this information the product can display any access restrictions imposed on a space that may impact the user's decision of where to study.

Figure 11 displays the same initial page, but because the user is logged in, a personalised greeting (1) and list of favorite libraries (2) are displayed in leue of the call to action. Selecting a favorited library from the list will cause a page with more details about the library to load, while selecting the My Favourites button will load a screen that contains a full list of favourite study spaces.

Figure 11 -- Home Screen, Logged In

Selecting the Location Filter button will load the location page. Likewise selecting the Occupancy Filter and All Spaces buttons will load the Occupancy and All Spaces pages. These buttons are available from most pages within the product, though they will be included

as small icons in the navigation bar at the top of the screen. A description of the additional pages of the Study Space Finder will be discussed in detail.

If a user would like to find a study space close to them, or near a specific location, they may choose to visit the **Location Filter** page (Figure 12).

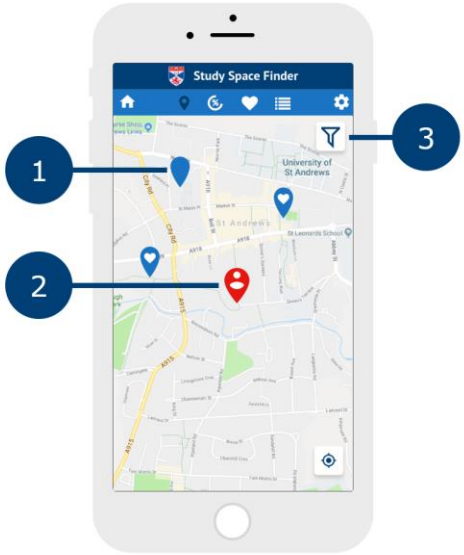


Figure 12 -- Location Filter Page

This page provides users with a map of available study spaces in a particular area, represented as blue pins on the map (1). If users allow the program to access the location data provided by their mobile phone, the map can also display their location in relation to the study spaces (2). Selecting a pin will open a small popup with the study space name, if it is open and a link to Google Maps to show directions (Figure 13).

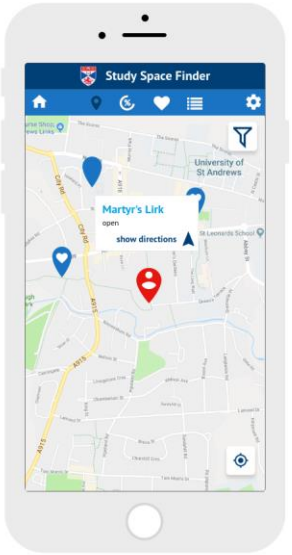


Figure 13 -- Location Popup

By clicking on the popup, a bigger popup window with information about the associated study space, similar to that shown in Figure 14.

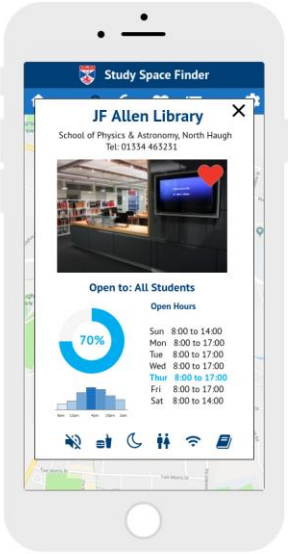


Figure 14 -- Location Popup

Users can use the map as they might other popular mapping applications, with the ability to zoom and pan the map.Additionally, a filter icon at the top of the page (3) would allow users to filter which libraries are displayed on the map using a variety of criteria. An example of the filters can be observed in Figure 15.

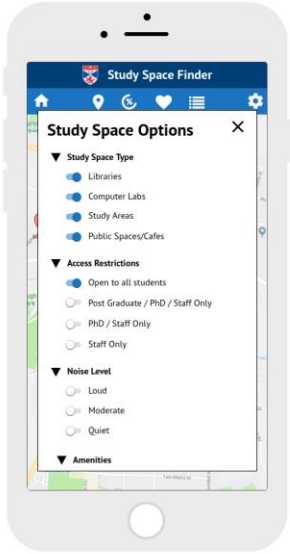


Figure 15 -- Study Spaces Filters

The filter motif is available in most of the product's pages, and would afford the same experience as displayed in Figure 12.

If users are more concerned about a study space's congestion level than its location, they may choose to view the **Occupancy Filter** page (Figure 16).

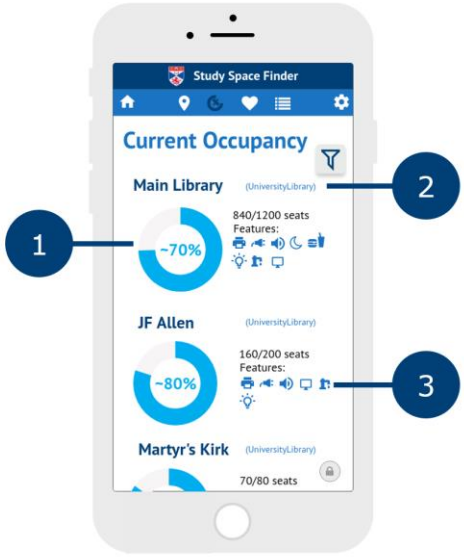


Figure 16 -- Occupancy Filter Page

This page allows users to view the occupancy level of a study space (1), which is derived either from sensor data, such as that provided by the Main Library, or from estimates based on historical data gathered by library staff. By scrolling down the page users can quickly get a sense for which spaces might best suit their needs, whether they are looking for a lively, active study location or a quieter location that may offer a greater chance of securing a seat. Other information regarding a location is available at a glance, including the category of study space to which the location belongs (2) and various characteristics or amenities the location provides (3). Selecting the occupancy level indicator icon (1) would load a page with more details about the space, similar to the pages displayed in Figure 19 and Figure 20.

The **My Favourites** page (Figure 17) allows users to see, at a glance, the opening hours of libraries they have favourited.

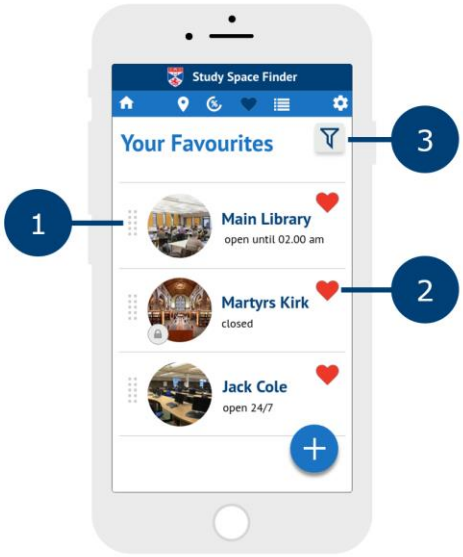


Figure 17 -- Favourites Page

Drag handles next to each favourited space can be used to rearrange the favourites' order (1) by long-pressing/clicking and sliding the selected item up or down on the page. Selecting the heart (2) next to an item will remove that item from the favourites list and from the My Favourites page. The filter button (3) would allow users to select criteria by which the study

spaces should be filtered, and would be an identical experience to the filter displayed on the Location Filter page. Selecting a space by tapping or clicking its icon or label will provide an experience similar to the Space Profile page described below.

The final study space finder option, called **All Spaces** (Figure 18), allows users to view every space included in the product as a list.

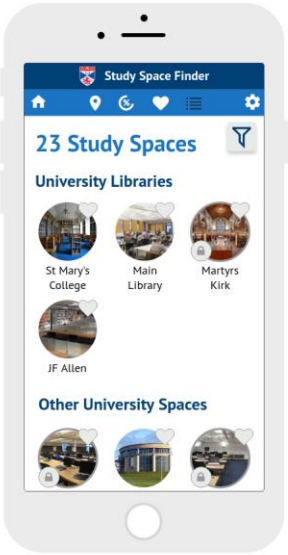


Figure 18 -- All Spaces Page

By default this list is sorted into categories (1) such as University Libraries, Other University Spaces, Cafes, and Other Spaces. The study spaces would then be represented by small pictures (3). Selecting a picture will present users with a Space Profile page similar to that displayed in Figure 19 and Figure 20. Selecting the heart icon (4) that is overlayed on a study space picture, will add the space to users' My Favourites list. Selecting the filter icon (2) will provide the same filtering experience as described for the Location Filter page.

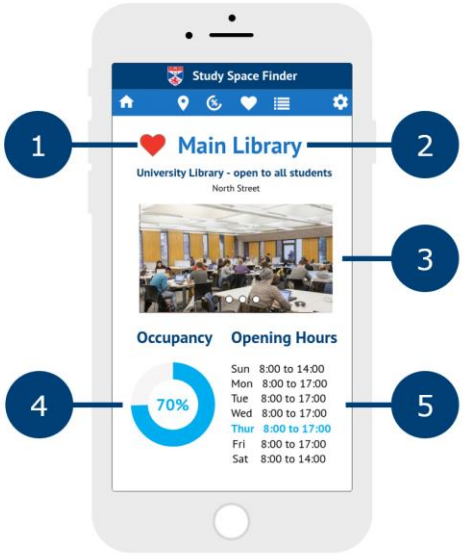


Figure 19 -- Space Profile Top of Page

The **Space Profile** Page (Figure 19) displays detailed information about a study space. A heart icon (1) is included to indicate if the space is part of users' favourites lists, which can also be pressed or clicked to add or remove it from that list. The name of the space (2) is available at the top of the page, and is followed

by a picture or series of pictures (3) of the space. If multiple pictures are available users can scroll through them by swiping left or right on the pictures.

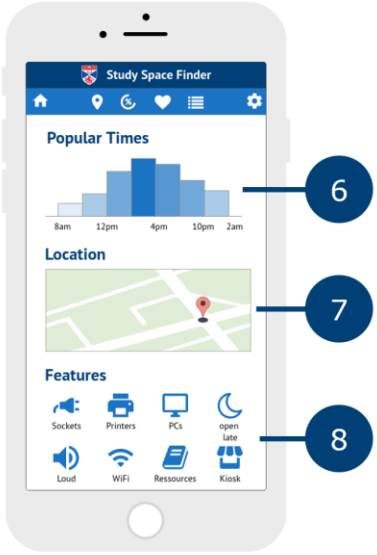


Figure 20 -- Space Profile Bottom of Page

Information about the current occupancy (4) for the space (when available) and opening hours (5) are provided, as well as an estimate of the popular times (6) for the space on that day, which is derived from historical data collected by the library staff. A location link (7) is also available on the page, and selecting it will take users to the Location page described in Figure 12, but with the selected study space highlighted on the map. Finally, a list of the study spaces attributes and features (8) is included at the bottom of the page.

The product also provides the University of St Andrews with a mechanism for communicating important information to students as the occasion arises. Announcements from Library Services, such as extended hours or "pop-up" study spaces, can be displayed on the home screen, as shown in Figure 21.

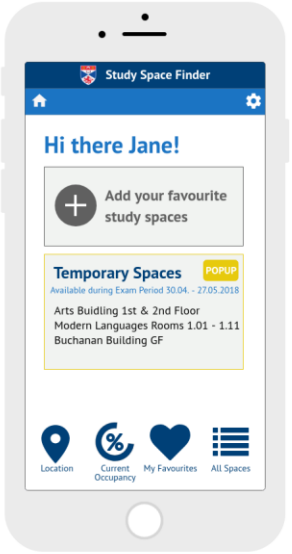


Figure 21 -- Library Announcement

In the case of new or pop-up study spaces, selecting the announcement will load the All Spaces page with the new/pop-up spaces listed at the top of their respective categories, with an icon indicating their status (Figure 22).

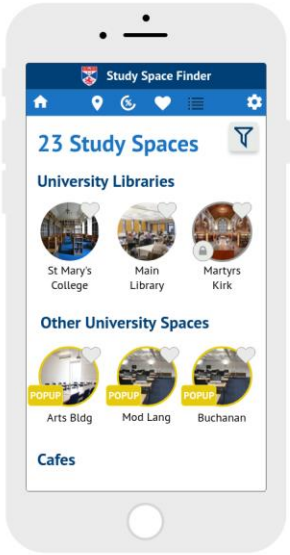


Figure 22 -- Pop Up Spaces

CONSERVATIVE LARGE SCREEN PROTOTYPE

The experience for users with large screen devices, such as computers and tablets, will closely mirror that of the mobile experience, but with a few notable exceptions.

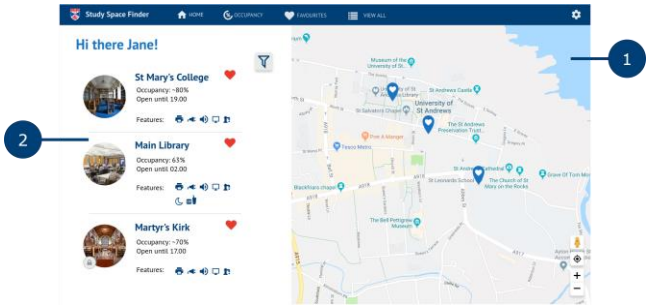


Figure 23 -- Large Screen Home Screen, Logged In Experience

As illustrated in Figure 23, a map (1) will be displayed on every page of the product and will interact dynamically with items displayed in the panel (2) on the left. Moving the mouse pointer over a pin on the map will cause any corresponding items on the left to be highlighted, while moving the mouse over items on the left will cause a small tooltip style dialog to display near the associated map pin (Figure 24).

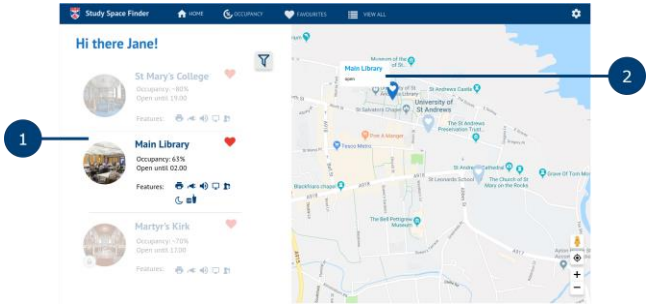


Figure 24 -- Large Screen Home Screen, Highlighted Study Space

Clicking on an item in the left panel or on a pin in the map will cause a dialog to appear over the map with detailed information about a study space (Figure 25).

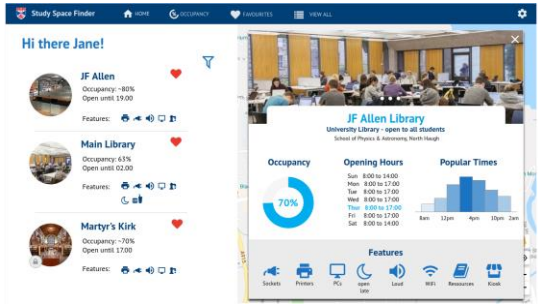


Figure 25 -- Selected Space Dialog

The included information would mirror the information provided in the conservative mobile prototype, with one exception. If the image of the study space is clicked, an image gallery would be presented, which can be explored by clicking the arrows to either side of the displayed image (Figure 26).

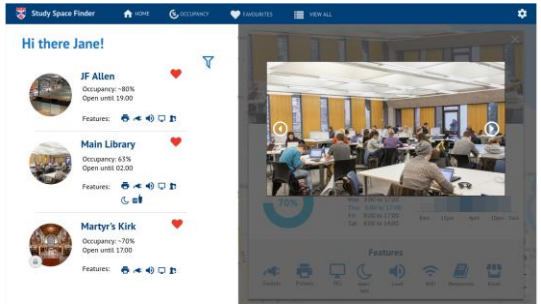


Figure 26 -- Selected Space Image Gallery

Out of the Box Prototype

The Out of the Box (OOTB) prototype approaches the goal of helping students find study spaces using a significantly different method than that represented by the conservative prototype. One might compare the OOTB to mobile applications that are popular with the majority of the St Andrews student body.

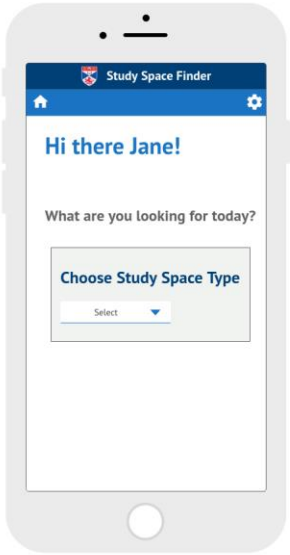


Figure 27 -- OOTB Home Scree

The OOTB product presents users with a series of questions to determine the type of space that would most suit the users' current needs. The home screen (Figure 27) first allows users to select the type of study space they would prefer. The various options include "Library," "Group Study Room," "Café," and "PC Lab" (Figure 28).

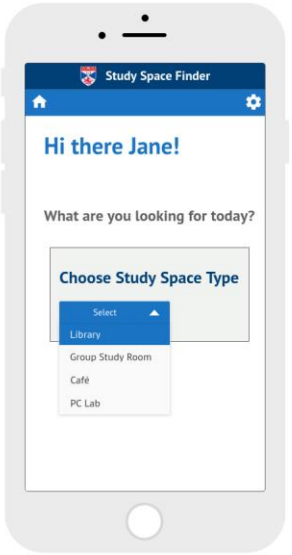


Figure 28 -- OOTB Home Screen Dropdown

The next two screens request additional information to help refine the choice of study spaces. Examples herefore are are shown in Figure 29 and Figure 30.

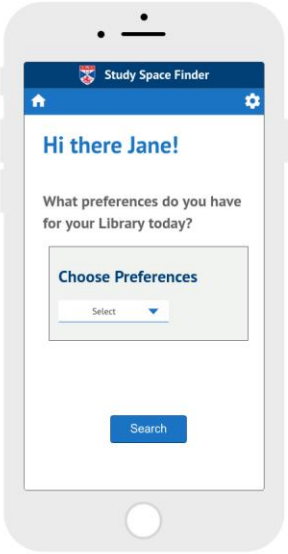


Figure 29 -- OOTB Space Preferences

The user would select the preferences such as ambiance or noise level and select as many as they want. This action mirrors the filter action of the conservative prototype.

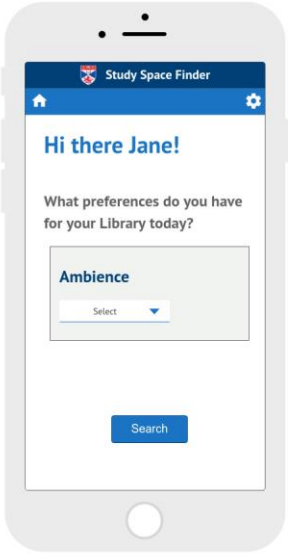


Figure 30 -- OOTB Ambience

Taking the users' selections into consideration, the program then displays study spaces that it determines would best suit the users' needs. This happens either when the user has gone through all the selection option or by clicking on the "Search" button. The study spaces are then displayed one at a time, as shown in Figure 31.

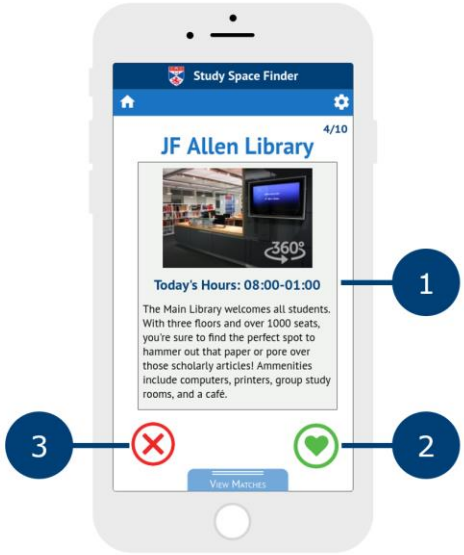


Figure 31 -- OOTB Study Space Selection Page

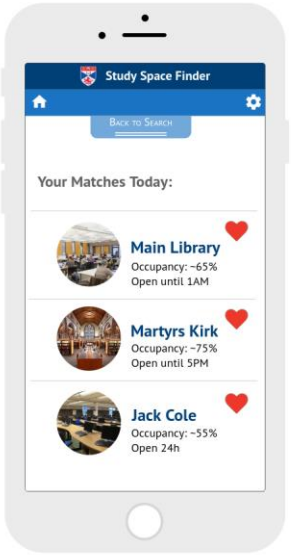


Figure 32 -- Selected Spaces

The Study Space Selection page displays the name of the space, an image gallery and a short description (1). If users like a particular study space, they can swipe their screen to the right to indicate a possible match, or left to reject it. Alternatively, they can click the "x" icon (3) or the heart icon (4) to achieve the same result. Swiping up on the screen or clicking the "Show Matches" icon (5) would then display the list of matches the user has selected (Figure 32).

Pressing or clicking one of the selected study spaces would then load a page with a full description of the library, as shown in the conservative mobile prototype, and the same interactions would be available. Pressing the "Back to Search" icon would return the user to the study space matching screens so they can continue the matching process.

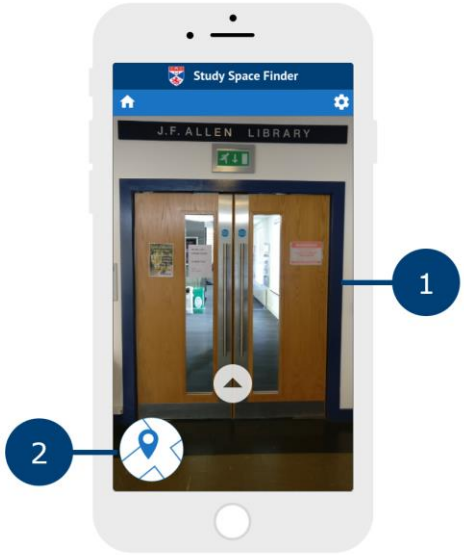


Figure 33 -- OOTB 360 Degree View #1

If a user would like a better idea of the options available in a study space, they can press or click on a picture in the gallery to gain a 360 degree view of the space (Figure 33).

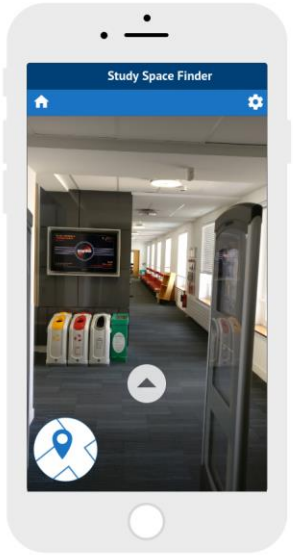


Figure 34 -- OOTB 360 Degree View #2

The user can pan the image side-to-side in order to see more details about the space (1), or progress through the space by clicking the arrows in the image. Additionally, a map of the space (2) would allow the user to navigate the space by pulling the map in the direction they would like to move.

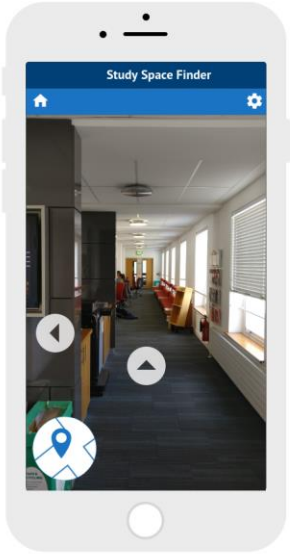


Figure 35 -- OOTB 360 Degree View #3

Figure 33 through Figure 36 demonstrate the experience a user might have as they progress through the front doors and into the JF Allen Library using the 360 degree functionality of the product.

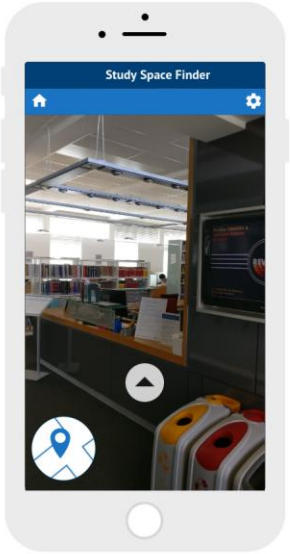


Figure 36 -- OOTB 360 Degree View #5

In addition to the arrows and map icon, the user can navigate using a map of the space, as shown in Figure 37. Pressing or clicking a location on the map would load a 360 degree image of that location.

Figure 37 -- OOTB Map of Study Space

Further functionality, such as creating or logging in to a user account, are not detailed in this prototype, but would be replicate the experience described in the conservative prototype.

Analysis of Key Alternatives

In order to develop as many ideas as possible in the ideation process, we first started sketching individually before discussing and further exploring the results. This led us to multiple ideas besides those presented above. In the following we will discuss these additional ideas and explain to which extend they were incorporated into our final prototypes. We will then present our decision process for our final prototypes.

Sketching Alternatives – Conservative Solution
We were able to incorporate many of our solutions we sketched out throughout our ideation process into our final prototype, which is why our sketching alternatives for our conservative solution are minimal.

One of the first ideas we sketched out, was the possibility to book a specific seat within a study space. The user would browse through the seating areas and be able to select a vacant seat to book it for a specific time. This idea, however, was soon discarded due to limited resources and funding. We decided therefore to include this option in our OOTB solution, as it might be achievable in the future.

Sketching Alternatives – Out of the Box Solution
In contrast, the number of alternative solutions for the "Out of the box" prototype was more numerous. Our final OOTB prototype combines aspects of some of these solutions. The corresponding decision tree is shown in Figure 37.

One first idea was to limit outside volume through a device, placed inside the ear. One of the detected problems students have, is to find a space with the perfect noise level. This device would have the ability to solve this problem by adjusting the noise level as needed. As this device would only resolve one of the students' needs, as well as again due to budgetary restrictions, we discarded this idea.

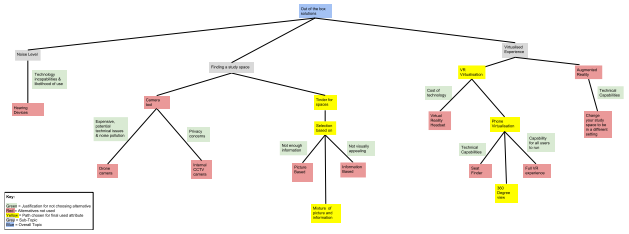


Figure 37 -- Out of the Box Alternatives tree - Please click for a larger version

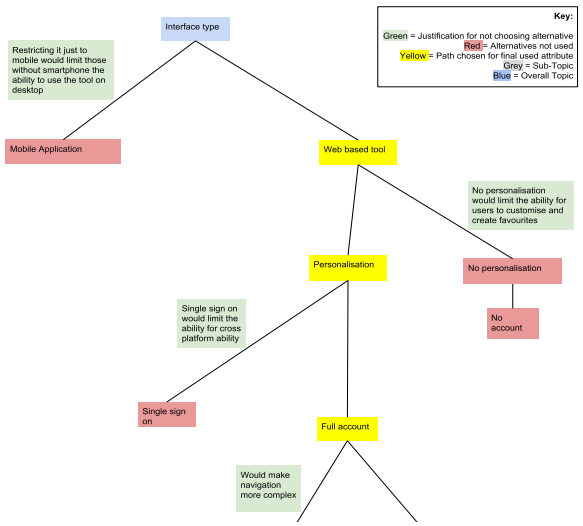


Figure 38 -- Interface Alternatives Tree - Please click for a larger version

Next, we developed the idea of a virtual reality headset system, that allowed the users to virtually walk through the study space in real time and locate vacant seats as well as evaluate the occupancy situation in general. On this basis, we wanted to further increase this VR system by providing the user the possibility to change the perspective as if they were there, sitting in a specific seat and manufacture the feeling of being in a that study space, while being at home. Whilst we did appreciate this idea, as it would reduce the traffic in the libraries, the expense and the technology available now, make such a device unfeasible. We believe that in the future, when the price is reduced, and the technology improves, something along these lines could be useful in improving studying at home.

Our third idea was to use drones to fly to and into the libraries to inspect the occupancy level. This solution would have alleviated the issues regarding finding a study space as it would be possible to assess from home how likely it is to find a seat in a particular study space. However, potential limits to the connectivity and the noise drones create, ill-advised using such a system.

Lastly, we developed the idea of installing and using already installed cameras in the study space buildings. These cameras would provide the users with a live image feed and enable them to click through the different areas to detect available seats. This idea, however, was rejected by the client due to privacy issues. For this reason, we excluded all further ideas that involved the use of cameras or CCTV.

Prototyping Alternatives

As well as for the sketching alternatives, there were multiple alternatives in the development of our prototypes. These and the underlying decision process will be discussed in the following.

The very first decision was to develop a web-based tool rather than a mobile application. While a mobile

application would benefit from the widespread availability of smartphones, it would exclude the possibility to check information on laptops and other desktop experiences, which, we found out during our contextual inquiry, was almost as dominant as the mobile usage. We decided therefore to focus on a mobile-first website, that was as comfortable to use on a phone as on a desktop and to prototype both experiences.

Next, we debated on how to allow personalisation. We discussed various possibilities, such as cookies as well as full registration with name, Student-ID number, etc. and Single-Sign-On (SSO). In favour of the benefits that a registration offers, as stated above, we decided against cookies and prototyped a full registration, however included the idea of the SSO in our report and the presentation to our client. Furthermore, both the clients concept statement and our contextual inquiry suggested that the students oftentimes are confused over which spaces are available to them due to access restrictions. This is one of the main problems, personalising the experience would be able to solve, by indicating unavailable spaces.

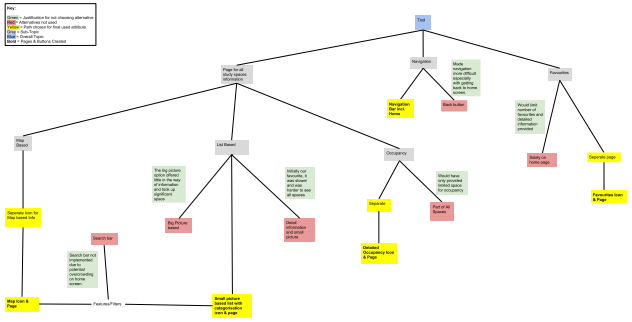


Figure 39 --Prototypes Alternatives tree - Please click for a larger version

The next larger decision to make was the inclusion of a navigation bar or relying solely on the back and forth buttons provided by each browser. The latter would offer more space for the website itself, however the navigation bar allowed quicker navigation through the different features the site presents. Based on user experience guidelines and to ensure good navigational flow, we decided on the implementation of a navigation bar at the top of the page, to limit the user actions needed to achieve the different user goals.

Another alternative we considered, was to solely implement the Favourites on the home screen rather than having them additionally as a separate screen as well. The benefit of this would be to have a sole resource from which to make edits and see all the spaces. However, we found, that in the case of multiple favourites, this would hinder a view with detailed information, which should be the value in selecting favourites in the first place. Consequently, we decided a separate dedicated page would allow for better edits

and manipulation as well as offering the possibility of seeing more information at one glance.

Regarding the design, we iteratively reviewed our choice in colours and changed them multiple times throughout the prototyping process. Feedback from our client for instance made us change the colours of the map icons, as it was not clear which of the icons was the user's location. We change this and differentiated the icons to demonstrate more clearly what was the user and what were the spaces. We initially chose yellow, green and others to reflect occupancy levels, which however was not intuitively understood. We therefore decided against this alternative in favour of a more uniform theme, keeping the colours of the tool and of the St Andrews branding.

Another key debate was on the design of the "All" page of our study space finder tool. An alternative to the final solution would have been a simple scrollable list that featured more information at once, but would have dismissed the possibility of the categorisation of the spaces. This scrollable list again had two alternatives in design, one that focused on the images and one that focused on the information. Both the client's feedback and the design critique pushed us toward our final decision. It was found that the main information useful for such a study space finder were not the pictures, but the information and most of all the categories of the spaces.

Next, we developed the idea of merging the occupancy page with the "All" page. This would have reduced the pages by one and compressed the whole into a more compact tool. However, we decided against this idea, as one of the most important features gleamed from our contextual inquiry was the occupancy level meter, which was used by most of our participants. Therefore, we agreed that merging the pages would deprive the user from this specific experience of checking the occupancy levels of the different study spaces. The information would still be available, it would not however be as clear to see due to a significant amount of detail on the page. A separate page offers easier navigation as well as the overall information that this information is available to the user.

Our overall decision to build a mobile-first web-based tool was led by the fact that this would enable both the mobile and desktop use, while offering all information regarding study spaces.

Whilst this section encompasses some of the alternatives we decided on, there were many other versions that were changed and improved. These will be included in the appendices with links to the Moqups page.

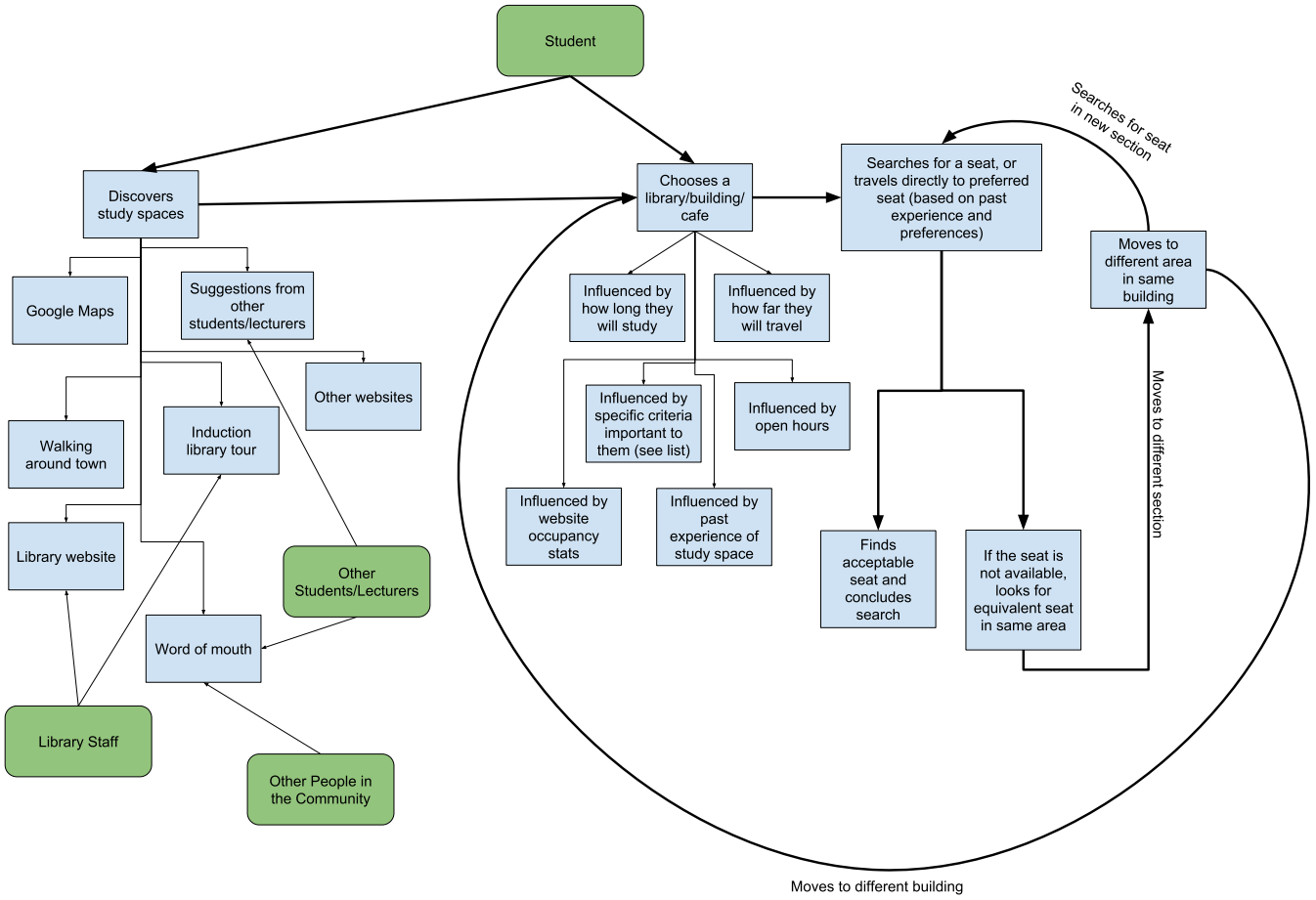
Conclusion

In summary, our work meets the client's initial requirements derived from the concept statement. Our solutions will improve the ability for students to find study spaces. The tool accomplishes this by advertising all spaces available, allowing users to find alternatives that will hopefully lower traffic to the main libraries.

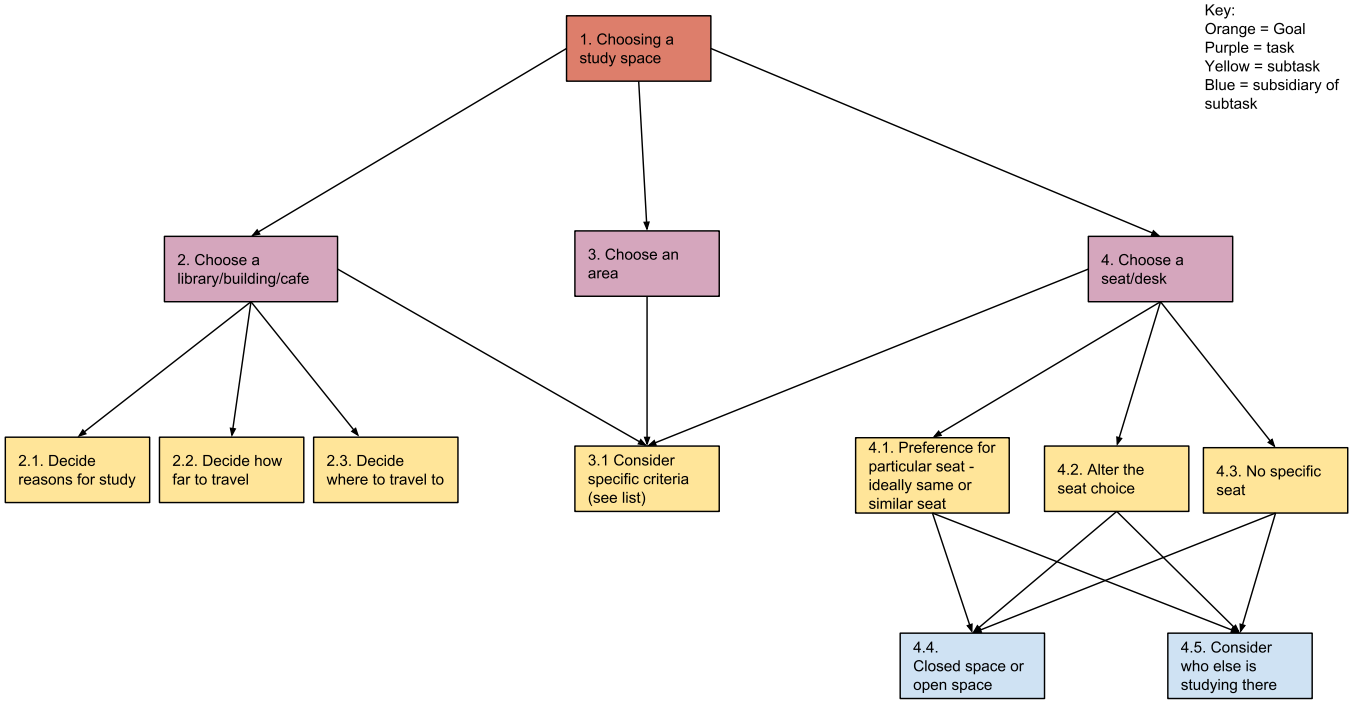
We also present an out-of-the-box solution that might not be applicable at this moment, however might be of use in the future. This solution demonstrates that we considered and formulated different ideas which could be valuable to our client.

Our work shows an ideation process and design thinking as well as multiple prototyping steps, which all contribute to this high-fidelity prototype, encompassing a wide range of features. If implemented this tool has the potential to improve the study space finding experience for students.

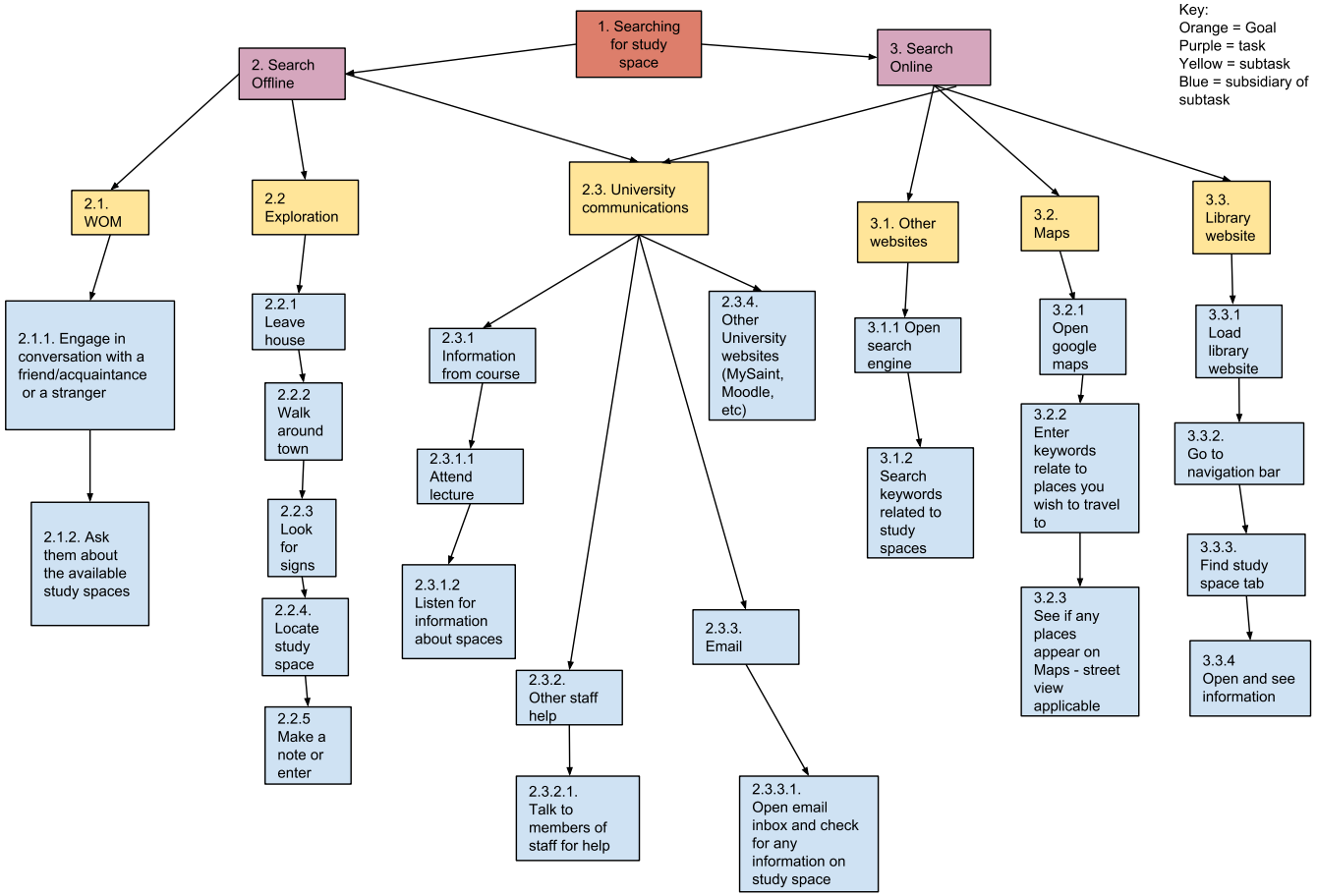
Appendix A—Workflow Model



Appendix B—Hierarchical Task Models



Criteria: Toilet Facilities, Lighting, Temperature, Noise Level, Opening Hours, Security, Atmosphere, Location, Space Availability, Resources, Food, Furniture, Personal Space, Support, Social Aspect


1. Searching for study space
2. Search Offline
3. Search Online
Key:
Orange = Goal
Purple = task
Yellow = subtask
Blue = subsidiary of subtask
2.1. WOM
2.2 Exploration
2.3. University communications
3.1. Other websites
3.2. Maps
3.3. Library website
2.1.1. Engage in conversation with a friend/acquaintance or a stranger
2.1.2. Ask them about the available study spaces
2.2.1 Leave house
2.2.2 Walk around town
2.2.3 Look for signs
2.2.4. Locate study space
2.2.5 Make a note or enter
2.3.1 Information from course
2.3.1.1 Attend lecture
2.3.1.2 Listen for information about spaces
2.3.2. Other staff help
2.3.2.1. Talk to members of staff for help
2.3.3. Email
2.3.3.1. Open email inbox and check for any information on study space
2.3.4. Other University websites (MySaint, Moodle, etc)
3.1.1 Open search engine
3.1.2 Search keywords related to study spaces
3.2.1 Open google maps
3.2.2 Enter keywords relate to places you wish to travel to
3.2.3 See if any places appear on Maps - street view applicable
3.3.1 Load library website
3.3.2. Go to navigation bar
3.3.3. Find study space tab
3.3.4 Open and see information

Appendix C – User Requirements

Information about different study space categories	**#1**
Showing what different study space categories exist in general	
User shall be able to see what different categories of study space exist in town [ID 010, 033, 112, 116, 124, 126, 127, 129, 132, 133, 134, 135, 150, 158, 204, 206, 241, 267, 285, 293, 294]	
Introduction of different study space categories independent of their location	
1) Page where the user can see all different category options (similar to existing list of study spaces) 2) Showing spaces with the categories of spaces they offer 3) Including cafes, class rooms & common areas	

Information about occupancy levels	**#2**
Showing information about traffic level	
User shall be able to see occupancy levels all over the campus before choosing a specific study space [ID 138, 140, 141, 144, 154, 165, 166, 168, 193, 206, 209, 219, 227, 233, 264, 265, 268, 269, 270, 271, 276]	
Show study space options based on occupancy level	

Information about free study space	**#3**
Showing information about space availability	
User shall be able to see if there is an available seat in a particular space [ID 003, 008, 012, 013, 021, 024, 027, 028, 037, 044, 045, 047, 194, 210]	
Show available seats by space	
1) Availability based on building, floor, area, room 2) Show general availability per default, option of breakdown in floor/area	

Information about specific seat	**#4**
Showing information about particular seat	
User shall be able to see if a specific seat is vacant [ID 004, 005, 014, 019, 020, 036, 055, 056, 180, 182, 184, 185, 186, 187, 188, 198]	

Information about access restrictions	**#5**
Showing information about access to study space	
User shall be able to see who has access to the selected space [ID 006, 009, 107, 111, 231, 234]	
Show access by building, floor, area	
Use user profile as filter for study space listings	

Listing study space features	**#6**
Showing information about offered features for each study space	
User shall be able to see what features are available in the study space [ID 023, 061, 062, 063, 064, 065, 066, 067, 068, 069, 070, 072, 076, 077, 078, 079, 080, 082, 096, 097, 161, 173, 174, 175, 176, 197, 205, 221, 240, 242, 244, 245, 247, 281, 282, 283]	
Facilities like toilets, computers, food offers, resources, wi-fi, power outlets, printers, parking (bikes & cars), blankets, heaters, water dispenser, furniture, security staff, help desk, etc.	

Filter Options	**#7**
Filtering study spaces based on criteria	
User shall be able to filter study space options based on personal preferences [ID 035, 057, 058, 060, 059, 071, 073, 074, 075, 084, 085, 086, 087, 088, 089, 090, 091, 092, 093, 094, 095, 099, 100, 101, 110, 158, 162, 163, 164, 165, 166, 167, 171, 172, 174, 177, 183, 189, 190, 191, 192, 195, 196, 199, 201, 202, 203, 204, 207, 211, 215, 217, 218, 221, 228, 229, 235, 238, 243, 246, 249, 259, 260, 261, 262, 263, 269, 282]	
Filter criteria: noise level, food/drink allowances, restrictions, atmosphere, light, temperature, opening hours, privacy, social aspect, etc.	

Information about study spaces nearby	**#8**
Showing information about available study space options nearby	
User shall be able to see available study spaces around their current location to minimize time for finding a seat [ID 018, 025, 029, 034, 046, 181, 200, 220, 222, 223, 224, 226, 237, 239, 272, 273, 274, 275, 277, 278, 279, 280, 284, 285]	
Show available study space based on user location	
GPS tracking with option "Show me study spaces nearby" (Google Maps)	

Information about amenities near the study space	**#9**
Showing information about nearby activity options	
User shall be able to see what the area has to offer [ID 026, 102, 201]	
Marking key features of the area	
Information about food places, supermarkets, parks, recreational areas (including opening hours)	

Various possibilities to access website/tool	**#10**
Linking website/tool in different systems to increase visibility	
User shall find link to tool/website in various systems [ID 109, 108, 118, 120, 123, 131, 141, 142, 151, 288]	
Visibility as key to success of tool/website	
Links in MySaint, Student Union, library website, university website, etc.	

Information about student satisfaction and recommendations	**#11**
Reviews and ratings of study space by users	
User shall be able to rate the study spaces to show overall satisfaction [ID 113, 114, 115, 119, 125, 128]	
5-star ratings with different categories	
1) Useful for feedback in general 2) Indicator for others with search based on filters	

Favourite Study Spaces	**#12**
Function to mark study spaces as "Favourite"	
User shall be able to save study spaces as "Favourite" locations to speed up the search process [ID 011, 015, 017, 024, 030, 039, 230, 232, 236, 260, 284, 291, 292]	
User Profile allows saving favourite spaces for improved usability	
1) Favourite can be seat/area/building 2) Save filters as default search settings	

Booking Feature	**#13**
Including feature to book study spaces	
User shall be able to see if they can book a study space and booking shall be included/linked [ID 139, 241]	
1) Optimal: integrating booking tool, else: link to booking tool 2) Showing booking policy	

Study Space Insights	**#14**
Include "good to know" information	
User can see interesting additional information about space which cannot be filtered [ID 59, 289]	
1) Insider tips, relevant additional information	

Contact/Interaction Page / FAQ	**#15**
Including a page for questions and interactions	
User shall be able to ask questions and interact with others [ID 132, 135, 110, 059]	
1) Most asked questions can be included in a FAQ 2) Questions shall be tagged for easy search	