Final Year Project Report

Full Unit – Interim Report

A Study in HCI

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A report submitted in part fulfilment of the degree of

BSc (Hons) in Computer Science

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Declaration

This report has been prepared on the basis of my own work. Where other published and unpublished source materials have been used, these have been acknowledged.

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Date of Submission: 01/12/2017

Signature:

Contents

Abstract

This report details progress made so far within the project outlined below. It also aims to plan the progression from this point to completion highlighting any alterations to initial planning milestones.

This project aims to compare various user interfaces and evaluate their design in terms of human usability. To achieve this various HCI issues which are present will need to be tackled including, but not limited to, variation between individual humans, cognitive issues, colour theory and typography. Through experimentation these factors will be manipulated and measured to find the optimum version of several interfaces.

There will be 3 interfaces each with a set of versions for comparison of their ability to overcome the HCI issues:

The first of these interfaces will be a simple website showing interactivity without multiple pages, having to scroll for more content, and menus to snap to these sections. The content of the website is likely to be a personal website to show information about myself in a stylised way.

The second will be a website for a small business, consisting of several pages that require navigational issues to be resolved, and aims to be suitable for users that are less computer literate. A few meetings with stakeholders and a specification will form more information regarding the requirements of this.

The third, final, and most challenging interface will be a mobile application for the android operating system. This provides many more HCI issues compared to a webpage as the mobile interface is smaller in general, and requires alternative input such as touch, however also will encompass all the issues from the 2 websites. This application aims to be a journal for a single user, showing previous entries that can be accessed and updated. Extension to this is very possible with association of images to the users input for a day for example.

Using knowledge from a HCI course completed previously, I will test variations of these websites and app that, hopefully, will show differences in them as positive or negative. Most of this will be A/B testing, as this is a simple methodology. As the project progresses, each test will have a hypothesis attached, when results from chi squared or t-test (in the case of discreet variables being measured) show the significance is high enough the null hypothesis will be rejected, and judgement can be made. In the cases where the null hypothesis could not be rejected, further investigation will be required.

To save some time and effort, low fidelity may be used in preliminary stages for changes to be completed rapidly in response to findings. Some research shows that users feel less pressured with low fidelity prototypes and may present issues more freely than if they perceive it to be finished.

Finally, a report will be written detailing the result and timeline of the entire project with a summary and evaluation of the user interfaces created.

In summary my project is to utilise HCI for an improved experience during interaction, unlikely to save lives or change the world, however highlights some key aspects that may in the future be applied to such projects.

Chapter 1: **Aims and Objectives**

1.1 Aims

To compare various user interfaces and evaluate their design in terms of human usability.

1.2 Objectives

Build 2 websites, and 1 android application. Website 1 will be compared to assorted colour palettes of the same design to determine how users perceive the colours. Website 2 will be compared to an existing website it aims to replace. The android application will be compared to variations of itself with layout, font and colour changes.

1.3 Methods

1.3.1 General

I have used GitHub to keep my work on as this allows branching for the various subprojects and access to the repository independent of workstation. Each use of GitHub follows software engineering, having the branch pulled, changed, pushed, and merged back into master when appropriate. Initially I had not been using GitHub and had instead been using a local backup alongside cloud storage, however with the size of the project files increasing and the need for branching becoming stronger I moved to using a repository once the code was large.

Each website and the application started with rough sketches that I could show to people to get their general thought for qualitative feedback and a simple choice between 2 sketches. The business owner had strong preference for the chosen style of website over their previous single page website despite having had compliments on it. The application sketches have not yet been presented for feedback yet, however soon will be and then a higher fidelity version will be made.

1.3.2 Website 1

The first website was initially using a template from www.startbootstrap.com, this was a great starting point using technologies I was familiar with, namely the bootstrap framework for HTML, CSS, and JavaScript. As my main aim is to vary the colour palette limited changes were made to the templates positioning, however content and design was altered to fit the purpose.

The first version of the website uses a standard colour palette which is like some in use today such as www.amazon.co.uk, which uses 3 main colours and various shades of them. To ensure the palette would be easy to see I used a method of grey-scaling all elements, this shows the contrast without interference from individual monitor settings such as contrast or colour sliders. As the website was still clear and readable I proceeded to create a secondary palette with only shades of green. This second palette was inspired by monochromatic clothing styles, such as blue suit, tie, and shirt combinations. Keeping with the clothing idea I wanted to test if websites would be perceived similarly to clothing colour is perceived by humans.

1.3.3 Website 2

The second website was initially using a template from www.startbootstrap.com due to the client wanting a specific style of website and having seen the template as an example limited changes

were wanted. The biggest changes were to the navigation of the pages due to having many removed and several new pages added that were near duplicates of existing pages.

Although still in progress due to waiting for content that the client will be providing myself over the December break a lot of the ideas I have discussed with the client have been accepted and will be put in place. The measure of this website will be against the existing website of the business, the client says they have had positive feedback of the current website, however it is out of date and the previous developer is no longer in business. Although the client did not notice it there are several HCI issues apparent to myself in the website, for example the scrolling is locked to what appears to be a time constraint resulting in the snapping feature limiting your movement up and down the page. The new website aims to resolve this by having no constraint to the users navigation, and having multiple pages to split the content logically.

1.3.4 Application

The application will be created using Android Studio primarily. Android studio uses a lot of java for the most part, however it also uses a lot of proprietary syntax that I have started to study and will continue to learn throughout the project. The application will be a journal with limited functionality with focus on the interface mostly. The app will be tested on Android phones as well as emulators that run within Android Studio. Currently the aim is to test different layouts of the app and the perception of colour palettes within the app, during development however there may be additional items to consider. I also aim to test the app icon in terms of HCI, this can be done using the time to find the app within a home screen or list of apps on a device.

Chapter 2: **Literature Survey**

2.1 Usability

In 1995 Nielsen revised the heuristics he originally developed with Rolf Molich in 1990 [1]. These heuristics are as follows:

> "Visibility of system status: The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
>
> Match between system and the real world: The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
>
> User control and freedom: Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
>
> Consistency and standards: Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
>
> Error prevention: Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
>
> Recognition rather than recall: Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
>
> Flexibility and efficiency of use: Accelerators — unseen by the novice user — may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
>
> Aesthetic and minimalist design: Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
>
> Help users recognize, diagnose, and recover from errors: Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
>
> Help and documentation: Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large."

These heuristics can have been used for the last 22 years internationally beyond the scope of what most would think of as "usual HCI". Some of the heuristics can be applied to interactions with cars, for example with the dashboard displaying the system status of the car to the driver (the user). These "golden rules" being available to use in many different situations during design have resulted in them being widespread and praised as the default to check against for any interactive system.

Nielsen's heuristic evaluation is largely unchallenged by any that would overthrow it, there are however alternatives to heuristic evaluation, pluralistic walkthrough and cognitive walkthrough also exist that can aid during design without user testing. Collectively these methods are known as usability inspection methods, aiming to start early in the project with targeting usability issues through design.

Pluralistic walkthrough techniques use users, developers and usability professionals. This has a higher organisation factor to consider when compared to heuristic evaluation which can be carried out solely by the developers checking against the heuristics. The benefits of this method however are that the developers see the users interacting at an earlier stage than usual user testing, allowing any concerns to be dealt with earlier too.

Cognitive walkthrough techniques have users accomplish tasks within the system being designed. The method has a task specific view instead of the holistic view of heuristic evaluation or pluralistic walkthrough that focuses on the entire system at once. Cognitive walkthrough benefits from the notion of user's tendency to learn through experience over reading manuals however, learning theory can dispute that whilst most users learn this way for many it may be the least effective.

During my design all of Nielsen's heuristics were easy to follow and check against without any external participation or funding, therefore these benefits ruled out the cognitive or pluralistic walkthrough techniques being used. I could have used an alternate set of heuristics such as Gerhardt-Powals' cognitive engineering principles [2], Schneiderman's Eight Golden Rules [3] or various others. Nielsen's however as is common within HCI Nielsen's can be used as needed with minor adjustments to fit the scenario due to their open-ended application.

2.2 Colour Theory

Colour perception has always been of interest to myself as someone with colour-blindness (red-green). Colour-blindness affects about 4% of the population with it more common in males. This is a large factor that needs to be accounted for during design of many interfaces. At an early age I believed that the green light of a traffic light was in fact white, this is not uncommon and many traffic lights in America now have a cross on the green "go" light to aid colour-blind drivers.

Colour theory does not simple stop here, every user will be affected by the colour within an interface in some way. Clarity, emotion, importance and brand can all be conveyed via colour. Misuse of colour could result in catastrophe. Users now associate red with danger, alert, or stopping due to widespread reinforcement of this within many interfaces. Alan Dix et. al reinforce this "If color is used as an indicator it should not be the only cue: additional coding information should be included" [4]. Additionally, they recognise that certain conventions exist, as mentioned above with red, for colour meanings that should be adhered to unless great reasons exist not to.

Colour theory is not always internationally standard, where red in the western world symbolises danger quite often, "in China it symbolises happiness and good fortune" [4]. This means that care needs to be taken in localisation for any interfaces.

Dix et al. also recommend checking how well your colours work for readability (regardless of colour-blind users or not) by grey scaling the interface and seeing if it is still useable. They suggest a couple of crude methods for this involving screen settings or printing with a black and white printer, I opted for using CSS to achieve the same result. They propose "if your screen is unreadable in grayscale then it is probably difficult to read in full color.". This is of immense importance when you consider that some older output devices may not have the full spectrum of colours available that you had when designing the interface.

Linking back to usability text colour can be utilised to signify state of system, for example a navigation bar might have white as its default text colour, but an active page might have blue for its link in navigation bars. This aids the user in visibility of system status as seen above in Nielsen's Heuristics this was a core factor.

2.2.1 Colour wheels

Colour wheels have been used greatly for determining colour schemes for interfaces for a long time, the first colour wheel documented was by Sir Isaac Newton in 1666. Since the initial colour wheels were created there have been a vast variety of them published and used. Some have hues of each colour forming spokes of a wheel out to the colour. A common simple colour wheel can be seen below (Fig. 1.)

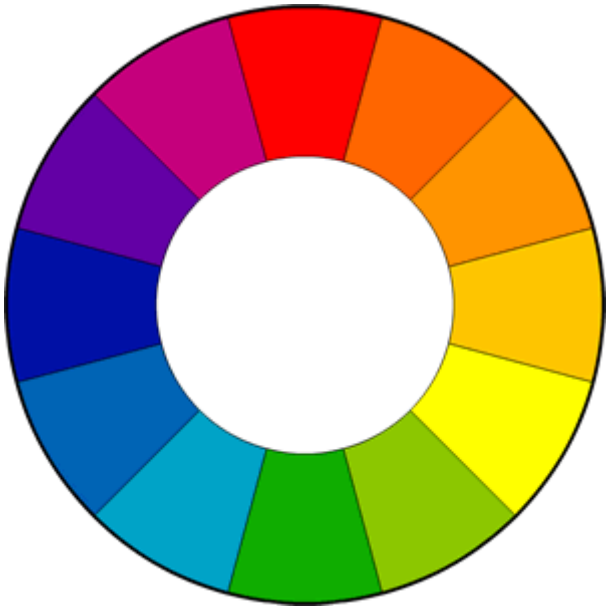

Figure 1.

The colours shown can be split into "warm" and "cold" colours usually with blue being the coldest (furthest from warm) and orange being the warmest (furthest from cold). The colour wheel has techniques for forming palettes known as colour harmonies. Complementary (polar opposites), analogous (neighbouring), triadic (3 equidistant colours), split-complementary (a colour and its complements neighbours) and many others, are types of harmonies. These harmonies in theory should work together on any white or black background. An example of this in use is Mastercard's logo which uses an analogous colour scheme: red, dark orange, and light orange (Fig 2.).

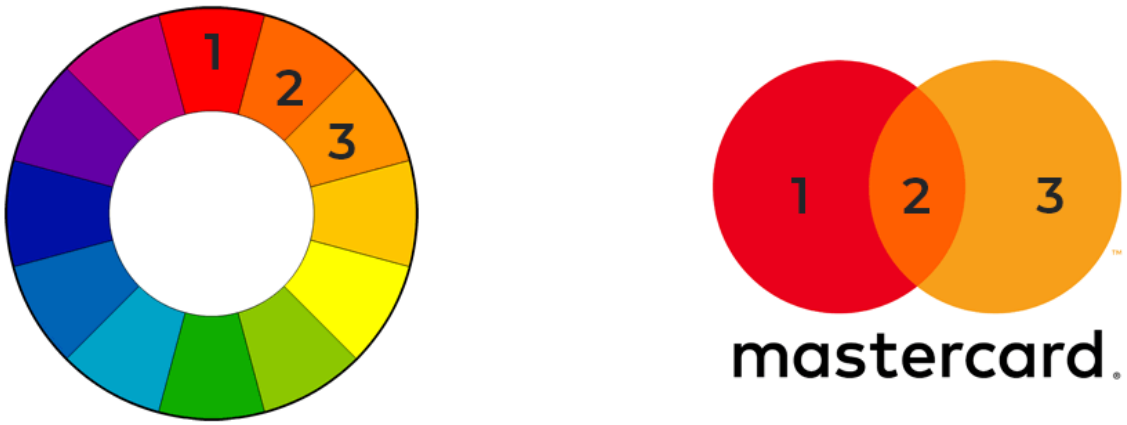

Figure 2.

Chapter 3: **Planning and Timescale**

3.1 Current

3.1.1 Research from 18th-29th September

This goal in the plan was achieved, I also used this time to meet with the client and discus the initial needs of the website for the design later in the project.

3.1.2 Website 1 and 2 from 30th September – 30th November

This goal was partially achieved, the first website is complete and ready for testing, however the second website is still under production and awaiting content from the client. The testing of the websites and the completion of the second website is being revised to finish by the 20th of December, working in parallel during the first weeks of the android application. Some initial sketches of the android have been completed and will be shown in Fig. 10-11 a later chapter.

3.2 Projected

Due to the website work deadline being pushed back I will be moving the start of the Android application back by a week to the 9th December. This will allow me time to complete other work and concentrate of the websites completion ready for testing. With a less busy schedule during the majority of December time allocated to the project will be increased and other deadlines should be able to remain as planned.

3.2.1 App from 9th December – 15th February

I aim to have completed the app by the 15th including testing of the various changes made to the app. This involves building the app from nothing, deciding on the HCI issues specifically to be tested, creating a hypothesis and conducting the testing. Once the data has been collected it will need to be statistically analysed to get meaning from it allowing us to reject the null hypothesis or require further investigation.

3.2.2 Testing

During the winter break testing of the websites will commence due to having more time to allow large windows for participation.

The first website will be given to at least 20 users who will try the two websites and have a feedback form to fill out, the form will have qualitative and quantitative aspects. The quantitative results can be analysed statistically and compared to a hypothesis relatively easily. Qualitative feedback will need to be interpreted or converted to quantitative data as best as possible to be compared to the hypothesis.

The second website will follow a similar methodology, the new website (variation) will be tested against the pre-existing website (control). The hypothesis will be based on the increased usability of the website in its newer form.

To eliminate as much bias as possible participants will be divided into 2 groups, the first group will receive the website versions in order A, B. The second group will receive the website versions in order B, A. Users will give feedback after each version for that version only then give feedback about both versions afterwards. This will remove any bias based on ordering of the versions.

Within the feedback forms leading questions will be avoided to avoid any bias here also. Questions quantitative questions will have options from one extreme to the other and where appropriate have an option identifying none of the other options.

The app will likely follow a similar methodology to the websites, however due to the running of the app requiring more setup the participants may be lower, resulting in a less reliable finding. This will try to be avoided by getting as many participants as possible however.

The testing will be cyclical if time allows. Where findings are inconclusive, or the null hypothesis cannot be rejected alterations will be made to the variation, with the control staying the same. Where some change is detected some additional changes can be made and tested against the original variant as the new control. This additional testing will follow the process shown below (Fig 3.)

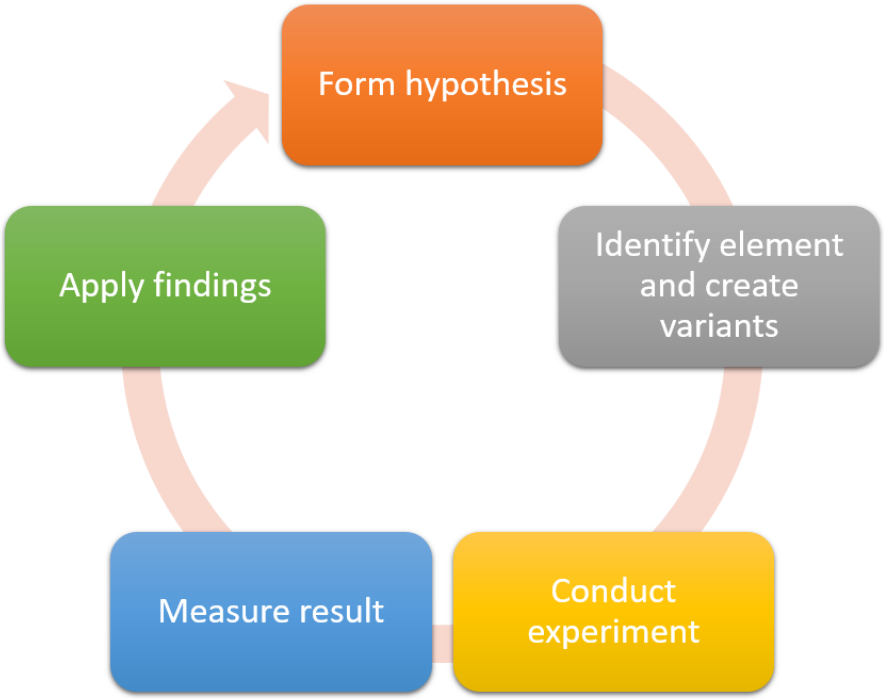

Figure 3.

Chapter 4: **Completed Work**

A diary can be seen in the appendix detailing dates of work.

4.1 Research

I completed research into current website layouts for general style of the websites in the project. Many use simplistic looks with a lot of space just being used by blocks of colour, or whitespace. This was a key part of the design of the websites. Many websites use 3 or less main colours, I decided that it would be interesting to go to the extreme with this and have a monochromatic website with just a single colour that would be used in different shades throughout the site. Another common feature was for navigation bars to be pinned to the top of the screen to prevent users needing to scroll to the top of the screen to use the navigation links. Both websites were to use this for easy navigation, even in the case of the single page website.

Before starting the websites or app, I took a while to put on paper concepts and general ideas for the deliverables (Fig 3.). Some of these were based on the requirements the client gave me, or what I assumed the client would want. These concepts formed the content of the first meeting with the client to discuss what they liked and didn't like.

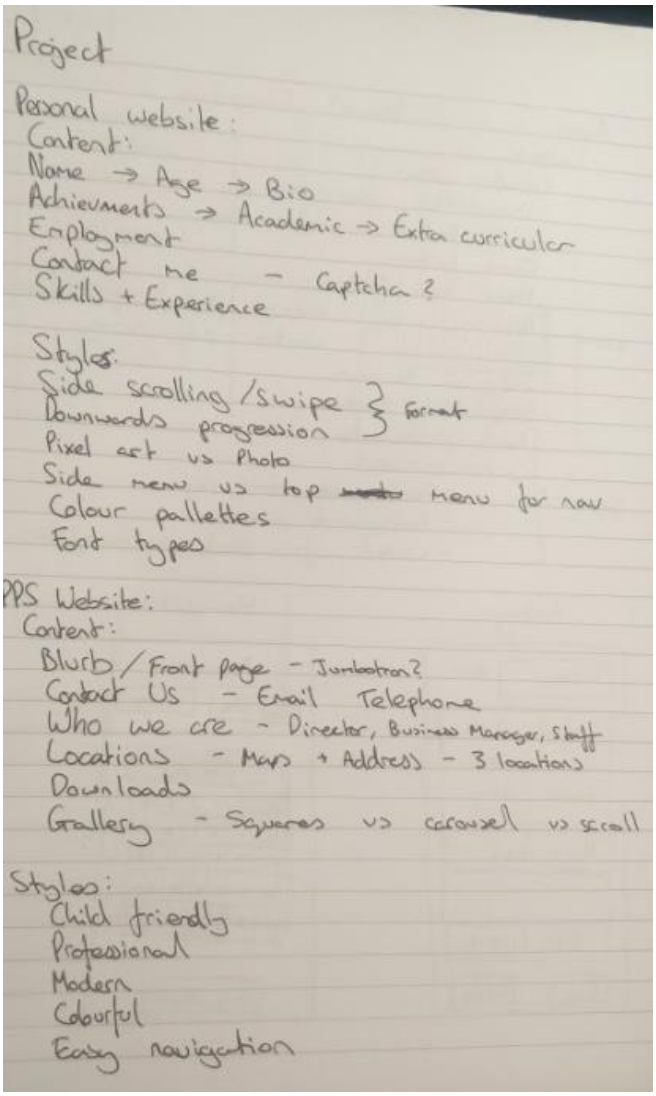

Figure 4.

4.2 Website 1

The first website was created using the findings of my research and the skills I had brushed up on prior to starting. I used the website startbootstrap.com to find an appropriate template. My focus was on the alteration of colour palettes and the change in how the website is perceived by users. As can be seen below the colour palette is 3 colours that are similar to many websites.

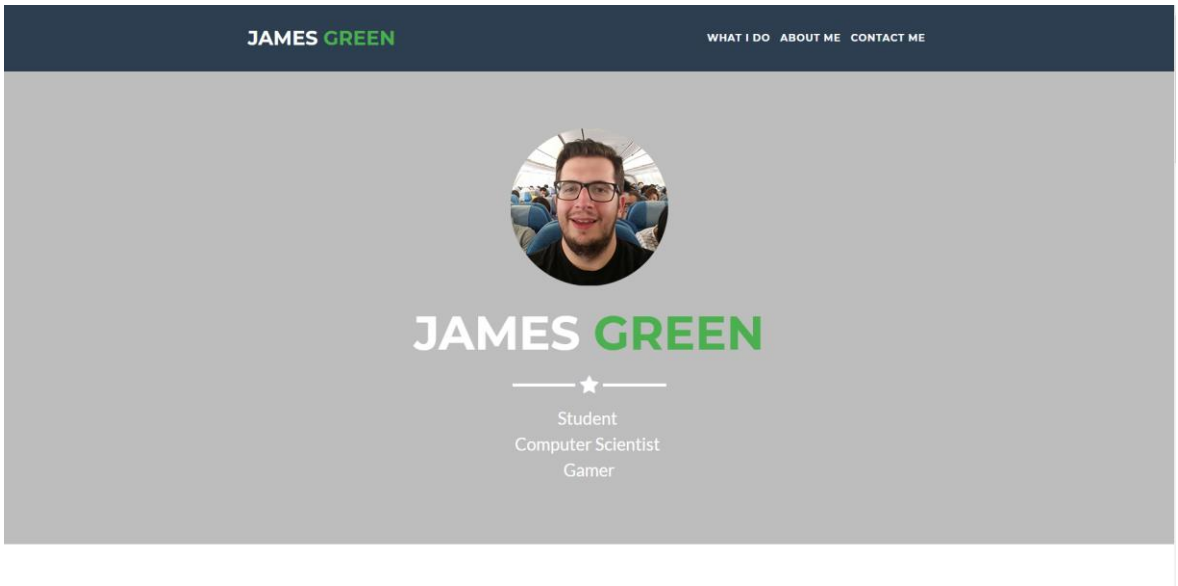

Figure 5.

The website as expected for any modern website reacts to screensize in order to be used on mobile devices with smaller screens. As can be seen below the columns aspect of bootstrap makes this easier to manipulate the CSS for thinner screens. In the smaller screensizes the navigation menu is compressed into an accordian menu that expands when clicked. Several elements that are side by side are now one per row such as the information at the bottom of the page. Additional feature that is present on the small screen version has a button at the bottom right for returning to the top of the page. This is good for mobile use as this is generally where a users thumb is near. Fitts law states that the time to acquire a target is a function of the size of the target and distance to it. Following this the distance being small should improve the time to acquire the target.

Figure 6.

During internal testing of the website I checked that the contrasting colours would be clear on other monitors using a method where a greyscale version is created. If the elements and text are clear in greyscale this means they will be clear and distinct on monitors regardless of their settings for brightness, contrast etc.

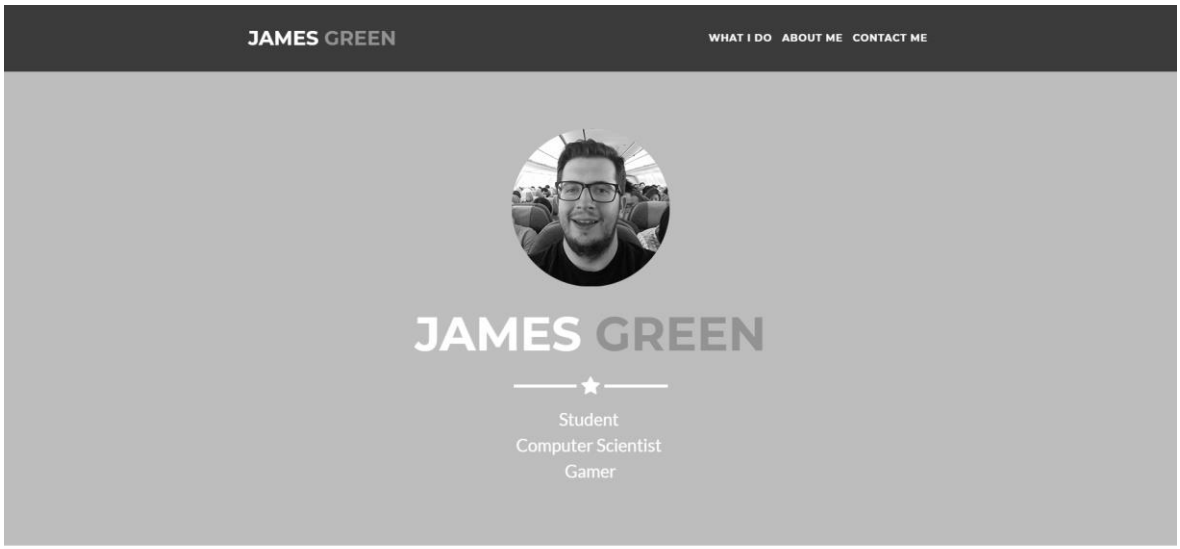

Figure 7.

As can be seen in the image no distinction is lost with the greyscale filter being added. To do this I used css to alter all the content within the HTML using the code snippet below.

```
html {
          -moz-filter: grayscale(100%);
          -webkit-filter: grayscale(100%);
          filter: gray; /* IE6-9 */
          filter: grayscale(100%);
      }
```

I proceeded to create an alternate palette version of the website using only shades of green. This was promted by the same principle being used commonly in fashion. A greyscale version of this palette would be mostly uneccessary as only one colour was used similar to how greyscale only uses black, and the images have already been seen in greyscale.

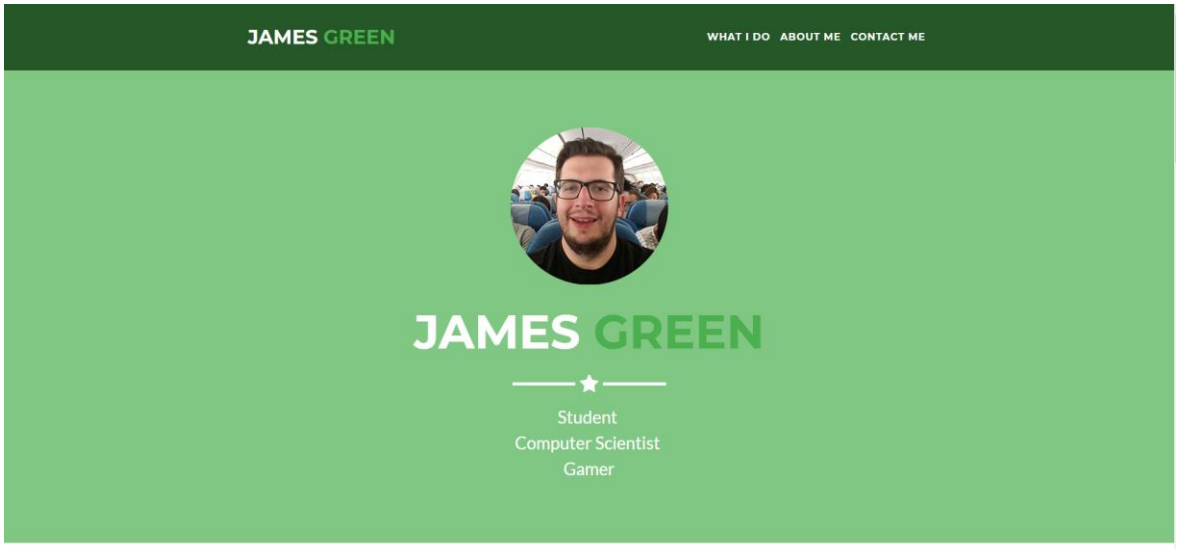

Figure 8.

Use of green only could produce perception similar to how clothing colours are percived. Colour palette effect on perceived approachability and professionalism Studies suggest in clothing medium dark colours are seen to show professionalism but can also be perceived as stern or intimidating. Similarly, pastel, earth and warm colours are perceived as friendly and approachable. This palette has various shades of green that fit the above perceptions, however green itself also has connotations. As the colour that takes up the largest portion of the visible spectrum humans find green easy to look at and therefore find it relaxing. There have however been signs that too much green correlates to apathy and laziness.

4.3 Website 2

The second website, similarly to the first, was created using the findings of my research. It also relied on the client's needs, and wants throughout its design and creation. I used the website startbootstrap.com to find an appropriate template once again.

The main aim of this website is to replace the existing one, however I also aim to have it solve some of the HCI issues present in the previous website such as navigational issues. To this end I have discussed with the client various approaches that can solve this. It was decided to have a navigation bar with access to all the pages from it, that would be present at the top of every page and move with any scrolling. In addition, there would be navigation from links within each page to relevant content such as more information about select services the business offers from the home page.

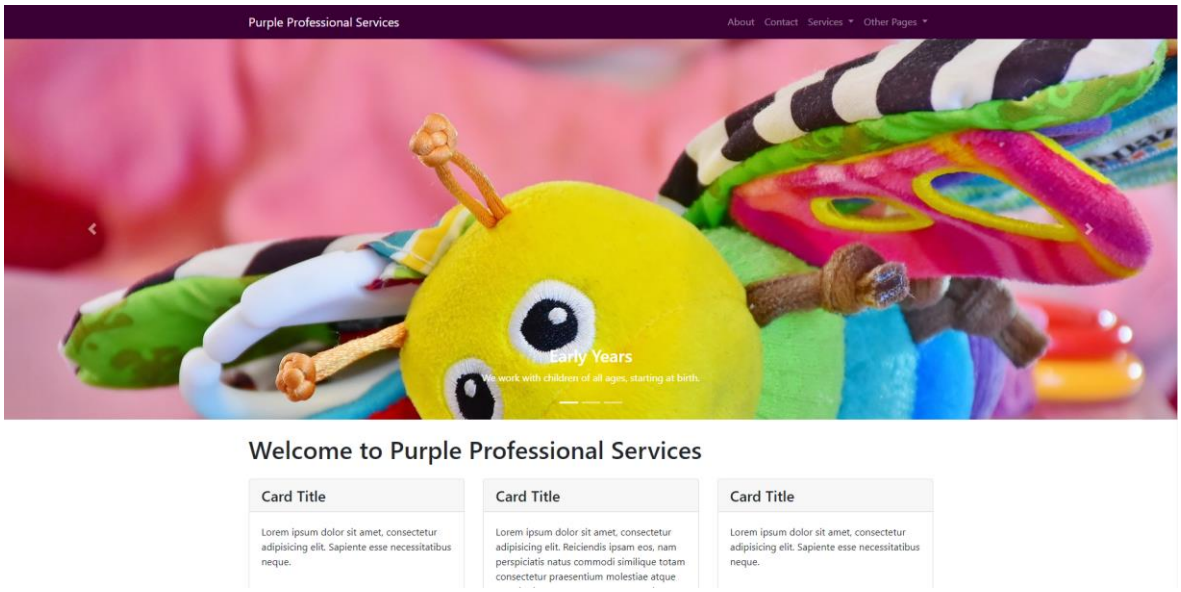

Figure 9.

I worked with the client to get colours that they approved of for the website, they wanted white and 2 specific shades of purple to be the primary colours used. These colours were chosen to match their logo. Use of these colours introduced issues I had not forseen and continue to work on. The lighter shade of purple in their logo is hard to find complementary colours for and is easily lost on most colours. Using it on white is effective however a white navigation bar gets lost easily when the background is white in the majority of the website.

Having to check with the client each time a change is made with regards to the 3 primary colours and the background has slowed the progress of this element of the project. The client wanted images for the jumbotron style carousels which required some back and forth whilst I found suitable free to use images that required no attribution.

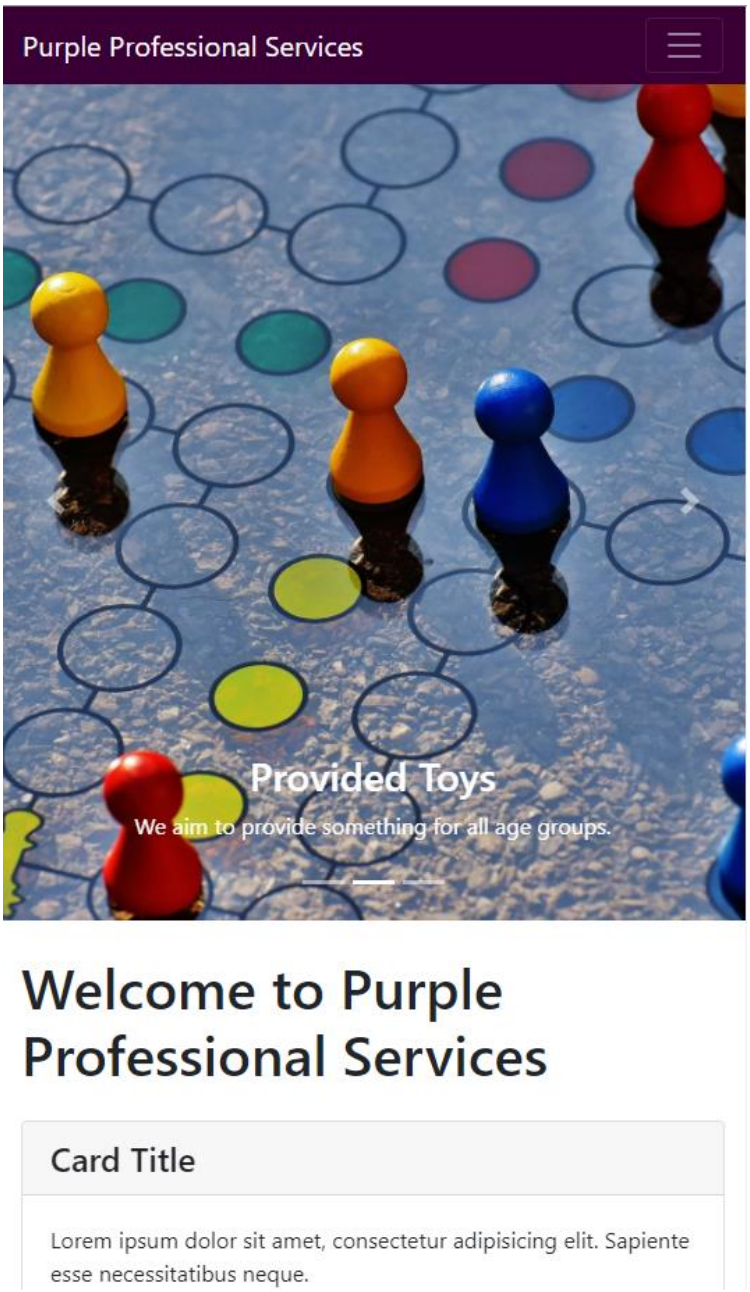

Figure 10.

Like the first website this is a responsive website that adapts based on the screensize as can be seen above. The same method is used with columns of bootstrap allowing simple responsive looking pages. As with the first website the navigation bar is shown as an accordian menu which expands and collapses as necessary. This site does not have the arrow to return to the top of the page due to having multiple pages which are usually quite small the feature was ommited but may be added at a later date to the pages which are longer.

Use of colour in this website was requested to be family friendly, professional and simple. During design I have strived for these feels, however testing is required to see if any changes need to be made. If changes are needed these will be tested against the first version.

Once the website is complete I will proceed with the greyscale test as done with website 1.

4.4 Application

Whilst without a computer I continued to work on the project sketching ideas of the app layout (Fig 10-11.). These are very basic, however show the various screens that would be needed for the app. Some of the concepts are for extension tasks such as an activity view or for photo and customisations.

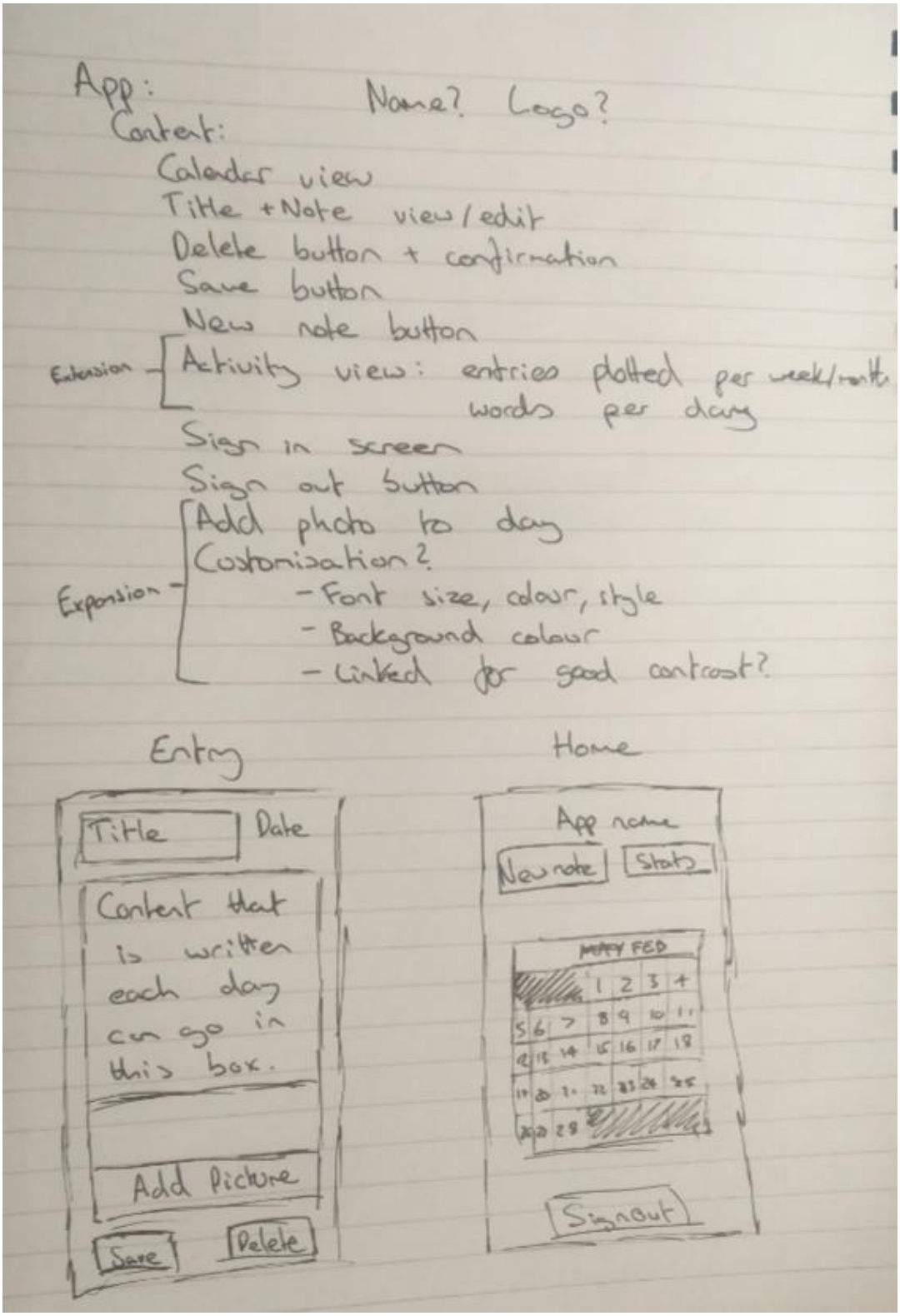

Figure 11.

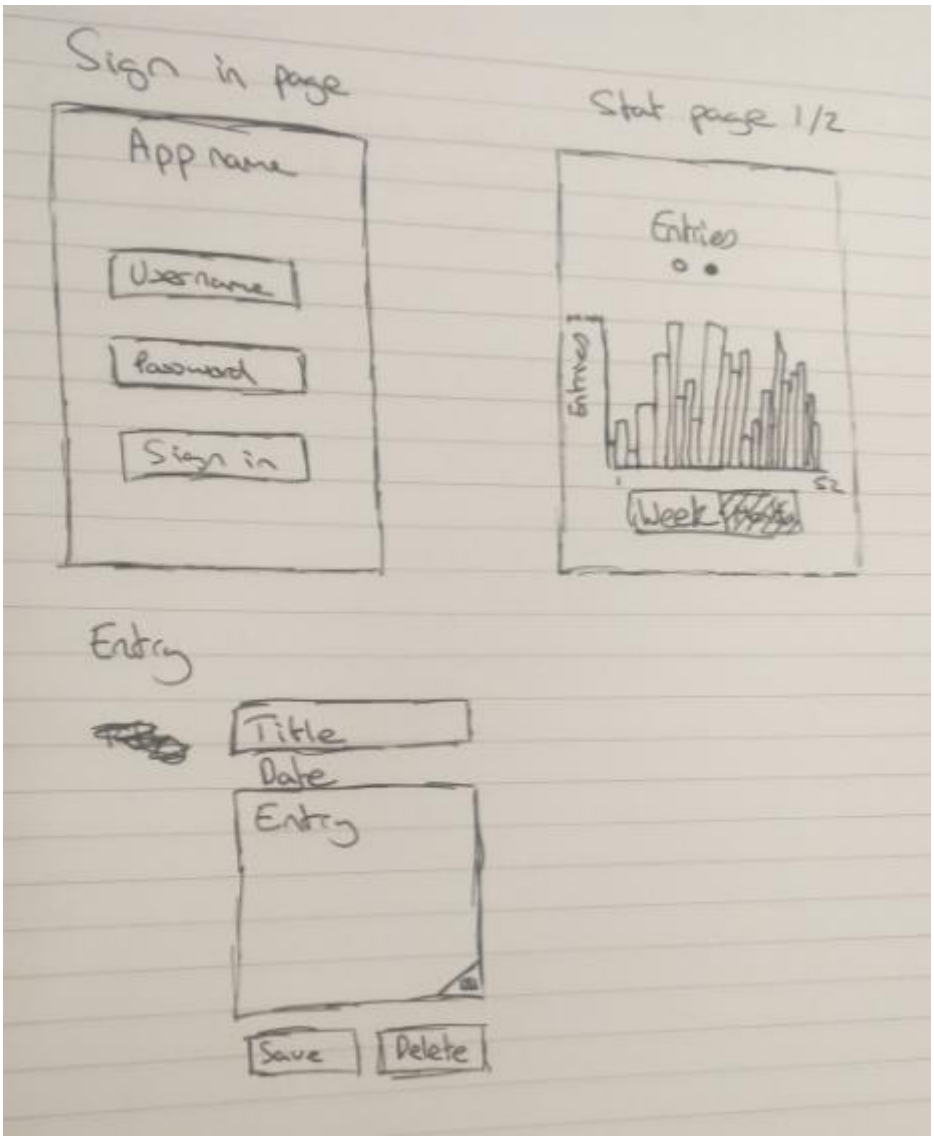

Figure 12.

As can be seen there are some aspects labelled as extension, these would require iterations of the app beyond the basic version. Ideally these will all be created once the previous iteration has been appropriately tested. Having looked at the functionality of Android Studio the basic app seems to be achievable at the very least. Some of the other features appear as though they may be beyond the scope of this project, however will be attempted should there be time.

4.5 Additional Work

4.5.1 Photoshop

I have been using photoshop during the project for colour manipulation, creating palettes to send to clients, and for photo manipulation for use in the websites. This will continue as the client has requested I take and edit photographs for their website. Within the second website a lot of the previous sites images were not accessible directly from the client and needed to be taken from the website and manipulated, however this was limited in its result. I may require time to recreate their logo from scratch for use with a transparent background as the website only has a white background image available.

4.5.2 Meeting planning

Due to the client being the managing director of the business meeting with them was hard due to their commitments. The client is not very tech savvy and therefore using a video conference such as Skype was also not an option. I arranged meetings where possible, usually at weekends when I was free to travel to them with my laptop to display options and take notes on what they wanted.

Chapter 5: **Professional Issues**

5.1 Use of Templates

In all projects plagiarism is a key thing to be avoided, when looking for ideas for websites I found many that were not available for use without payment, others could not be bought either. However, startbootstrap.com had a large range of templates that were free to use under MIT licensing (https://github.com/BlackrockDigital/startbootstrap-modern-business/blob/master/LICENSE). I have followed the copyright and included it where it was originally within the templates.

5.2 Consent of Participants

I aim to carry out testing of the various interfaces I produce, during these tests it is good ethical practice to obtain a signed consent form that highlights to the participants the key aspects of what they are participating in and allows them to withdraw from the study at any time. I will also ensure that participant confidentiality is kept if they desire.

Bibliography

[1] Jakob Nielsen. *10 Usability Heuristics for User Interface Design*. https://www.nngroup.com/articles/ten-usability-heuristics , 1995.

[2] Jill Gerhardt-Powals. *Cognitive Engineering Principles for Enhancing Human-Computer Performance*. Richard Stockton College of New Jersey, 1996

[3] Shneiderman, B., Plaisant, C., Cohen, M., Jacobs, S., and Elmqvist, N., *Designing the User Interface: Strategies for Effective Human-Computer Interaction: Sixth Edition*, Pearson, 2016

[4] Dix A., Finlay J., Abowd G. D., Beale R., *Human-Computer Interaction Third Edition*, Pearson, 2004

Appendix

Repository

https://github.com/zbvc216/A_Study_In_HCI

Diary

1:11 pm on November 22, 2017

Interim report draft ready for showing to Greg in meeting tomorrow. feedback will be applied, and report submitted in a week and a bit.

1:11 pm on November 22, 2017

Met with small business client to show current progress, will receive content during December for the website, testing will be delayed.

3:36 pm on November 13, 2017

Having issues with favicons, sometimes a key aspect of websites when trying to find the relevant tab. Could possibly be due to favicons not working when local rather than on a webserver.

11:58 am on November 13, 2017

Created grayscale version of personal website to test if the colours used are distinguishable on monitors and phones with different settings for colour, warmth etc. Also, a good test for colour blind users' ability to see the different shades against each other. I myself am Red/Green colour-blind and had no trouble with either version of the website. I will use this method again for the other website, and possibly for the app.

3:35 pm on November 9, 2017

Idea: App icon, also can be a HCI issue, some apps have similar icons and result in users needing to focus to discern the one they want from others. Examples of this phenomena: Shazam, Rewards, Relay, Discord, and Downloads all have white and blue in a circular design,

12:05 pm on November 9, 2017

Further HCI analysis available to compare large scale changes between clients existing website and the new one when created, arranged a meet with client over weekend to discuss the project further

1:02 pm on November 8, 2017

Idea for personal website HCI element to manipulate: Colour palette effect on perceived approachability and professionalism Studies suggest in clothing medium dark colours are seen to show professionalism but can also be perceived as stern or intimidating. Similarly, pastel, earth and warm colours are perceived as friendly and approachable. This could be true for HCI also.

12:51 pm on November 8, 2017

Personal website completed, Small business website begun. Second version of the personal website soon to start, deciding the HCI element to manipulate and test against. Limited work carried out in previous week due to complications. Contacted by 3rd party possibly wanting website assistance, will discuss with Gregory during meeting Thursday.

1:31 pm on October 26, 2017

Sent initial design options to business for thoughts on overall design

2:00 pm on October 19, 2017

Hierarchical task analysis of the app

1:19 pm on October 10, 2017

Sketch of app layout with various pages and revisions to fit buttons in logical places

11:45 am on October 10, 2017

Research: Looked at various existing applications and websites for an idea of what general style to use