Final Year Project Report

Full Unit – Report

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A Study in HCI

James Green

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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 Where other published and unpublished source materials have been used, these have been acknowledged.

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Signature:

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Chapter 1: **Introduction**

1.1 **Abstract**

This report details progress made within the project outlined below. It aims to outline the project goals and methods, background theory, the planning and timescale of the project, the research and work undertaken, and professional issues.

During website 1 production most work was done without any involvement of outside parties; all decisions were mine alone. The website was created using bootstrap and used colour to change user's perception of the website. Testing occurred once the website was complete and had 2 variants, one with monochromatic green shades, and another with a 3-colour palette. The results show that the users preferred the 3-colour variant overall, however did not have a strong enough significance to reject the relevant null hypothesis. The experiment overall resulted in data that strongly supports:

1. User's scoring of the feel of the website will decrease as the number of colours in the website decreases.

2. User's perception of the monochrome website will be more informal than the original website variant.

3. User's perception of the monochrome website will be less formal than the original website variant.

4. User's perception of the monochrome website will be more relaxing than the original website variant.

Website 2 required working with a client, this proved difficult having communication issues arise at various stages of the production. A client serving element introduced outside input being needed for many design decisions. The website was to be created and compared to the existing website which had many apparent HCI issues. I spent the first week of the project looking at and interacting with the website to isolate the issues and think of ways to improve upon them. Many meetings occurred where I gave the client options that could solve the issues and designed a colour scheme with the client that would work with their existing logo. When tested the newer variant had overwhelmingly positive results when compared to the existing one. The experiment overall resulted in data that strongly supports:

1. Users will rate the look of variant B higher than variant A.

2. Users will rate the feel of variant B higher than variant A.

3. Users will rate the navigation of variant B higher than variant A.

4. Users will describe variant B as more clean than variant A.

5. Users will describe variant B as more professional than variant A.

6. Users will describe variant B as less messy than variant A.

7. Users will prefer variant B over variant A.

All null hypotheses regarding website 2 were rejected due to having confidence of over 99.9% where 95% was the threshold for rejection. The issues identified within the existing website were

all seemingly resolved, however the content of the new website was lacking due to the client not providing it yet, however once this is provided the website will be completed and put to use as the live website.

The app was a harder endeavour and was not completed to a level that any HCI tests could be run on it. Issues both with the IDE and personal issues caused the app to not be completed. HCI issues were isolated ready to be tested with variations in interface layout, colours, design etc. In the future this project may be revived in order to complete the app or another app with HCI being a large component of its development. Included in the report are the current state of the app including images and plans for the product that would be tested.

1.2 Motivation

Since seeing and reading the information for the optional module Human Computer Interaction in my 1st year of undergraduate study I was interested in the area of research. In my final years of school I studied psychology, and I saw HCI a link between the science of computers and the mind. I later came to realise that HCI also deals with biology and physical engineering amongst other factors. As the 2nd year of my study progressed I developed more intrigue into the field of HCI and thoroughly enjoyed the module. Having done well in the results and enjoying it I was happy to have chosen HCI for my final year project. Prior to the start of the project I had limited website development practise and had not created an app but was exited to try these new ventures. HCI affects us massively in modern life from minor things to life altering ones, using what I learn in the project for future purposes that will benefit the world even at these minor levels is now an aspiration of mine.

Chapter 2: **Aims and Objectives**

2.1 Aims

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

2.2 Objectives

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. Website 1 will be compared to assorted colour palettes of the same design to determine how users perceive the colours.

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. Website 2 will be compared to an existing website it aims to replace.

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. The android application will be compared to variations of itself with layout, font and colour changes.

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.

2.3 Methods

2.3.1 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.

2.3.2 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.

2.3.3 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 user's navigation and having multiple pages to split the content logically.

2.3.4 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 3: **Literature Survey**

3.1 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.

3.2 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.

3.2.1 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.)
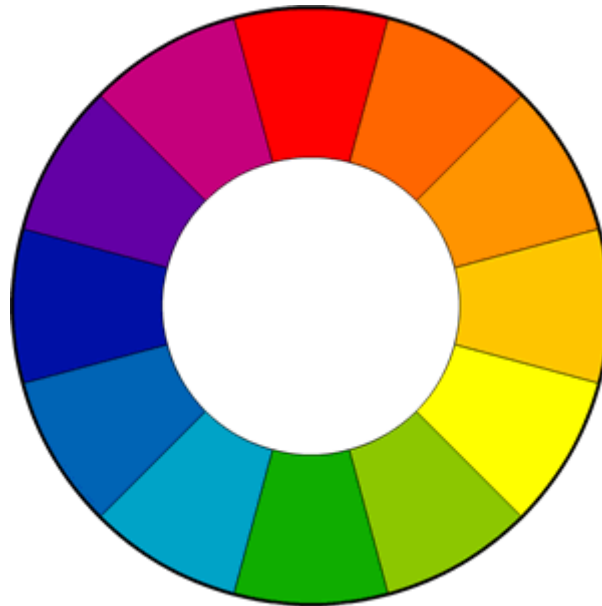
Figure 1.

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.

3.3 Fitts's Law

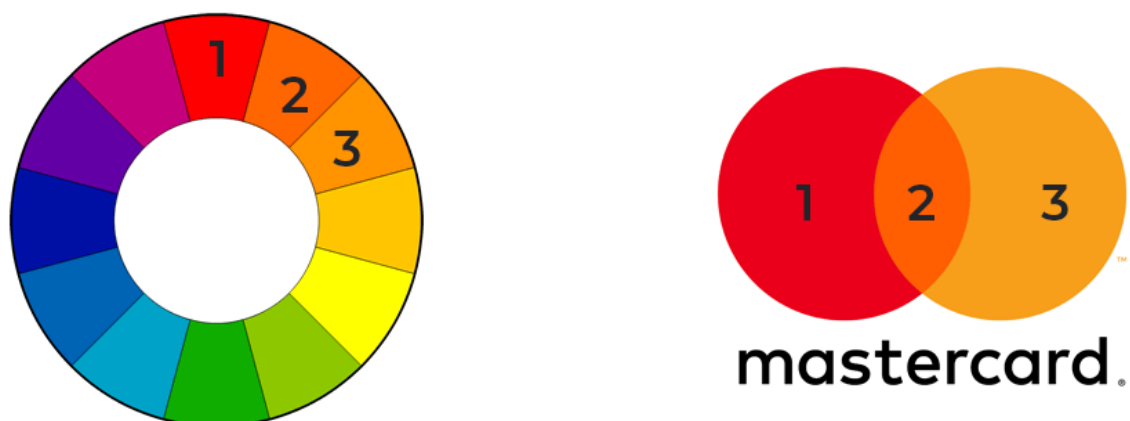Fitts's law is a well-known principle in HCI, it states that the size and distance of elements in UI's directly affect the usability of the element. There are various formulas that have been created with the consensus being that larger and nearer objects are easier to use as has been seen with increased speed of moving to and selecting a target. The law predates HCI and was initially used for physical design.

When applying the law to user interfaces the distance is usually measured from the average pointer position (or the resting position of a pointer such as finger for touch screens) to the target. With increased distance to move the time to target takes longer, and with decreased size target acquisition takes longer, decreased size also results in longer time to align the pointer to the target.

Application of the law results in more commonly used buttons being larger and nearer to the pointers average position than less used buttons. Due to the edge of screens usually having a boundary the pointer cannot cross common convention is to keep buttons here, artificially increasing the size of the target area as overshooting is much less likely. Popup menus such as the right click function in windows allows users to access buttons that are very close to the current pointer position although they are not usually large targets. Studies have shown that circular menus with equal distance from the initial cursor position are quicker due to their reduced average distance, however this can cause issues with many items in a circular menu having limited size.

Fitts's law interacts with Nielsen's heuristics in the fact that users will expect any part of a button to carry out the action, this means the target area should be as large as the button graphic allows.

3.4 A/B Testing

A/B testing was to be used during the project, this would be to compare 2 versions of user interfaces. A and B being the two variants to be tested. AB testing aims to determine which interface performs better at certain tasks. The variation can vary from minor changes to large overhauls that completely change the interface. In some cases, A might be a control interface that was existing prior to the project, however sometimes it will be an entirely new pair of interfaces where neither is the control, however it still works in this situation. Manipulation of variations between two interfaces can then be used to collect data regarding their impact.

Testing enables development to be scientific instead of relying on guesswork when making variations to interfaces. When presenting alternatives to product owners the testing enables informed decision making. Positive changes can be retained, and further changes can then be tested again in a cycle to keep improving the interfaces.

Usually a component of A/B testing is the distribution of participants between the two variants, they should be as close to evenly spread as possible. Even spread among the two variants aims to avoid any bias that could be introduced to either of them via having more or less participants data collected. Alternatively having participants interact with both variants can also achieve this if handled correctly.

When the users interact with their designated version recordings are made, this can be through various data collection methods. The data collection method is also important to avoid bias. A/B testing alone is not enough to get data that can be fully trusted. Below I will highlight some methods that I have researched to get data that is valid and reliable. [6]

3.5 Additional testing methods

3.5.1 Counterbalancing

Latin squares achieve counterbalancing to avoid ordering bias when users view and interact with an interface before or after the other. The square layout shows the order in which the two groups of participants are presented the variants as shown below.

Ordering of variants	Group 1	Group 2
Variant A	1st	2nd
Variant B	2nd	1st

Latin squares can also be used for more groups and variants and are usually applied where the number of variants and user groups are equal, however they are used as incomplete counterbalanced fashion. Incomplete counterbalancing compromises some benefits in order to be easier financially and timewise. Use of incomplete counterbalancing however will not be an issue during the project due to only having 2 variants at any one time. [7]

3.5.2 Consent

As 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.

3.5.3 Statistics

The SciPy library will be used within Python to calculate the p-values.

Where mean values are looked at such as the scalar values from the look and feel questions t-test can be used, this paired t test computes the difference within each user which cancels out the unique contribution of each user. This should reduce some noise in the results.

Chi squared is the appropriate test due to not having discreet variable data. I will pass in the contingency tables shown above and the chi2 also calculates the degrees of freedom for the lookup table for p-values based on the chi^2 value. Once completed the p-value will be returned. Neither row will be used as the expected values due to not having a well-established design currently in place.

These contingency tables all have 1 degrees of freedom as given by the formula:

degrees of freedom = (# of rows -1) * (# of columns -1)

If we were to manually calculate the P-values, we would follow the procedure detailed below:

The expected rates can be calculated using the following formula:

$$\text{Expected rate of A} = \frac{Total\ Column\ A}{Total\ Column\ C}$$

$$\text{Expected rate of B} = \frac{Total\ Column\ B}{Total\ Column\ C}$$

The expected rate is them multiplied by the total of each row to get the expected number for that variant. These figures can then be displayed in a table as shown below.

	Measured variable		Inverse of measured variable	
Variant	Observed	Expected	Observed	Expected
A				
B				

For each variant and measured variable and its inverse, we calculate the chi^2 with:

$$\frac{(observed\ value - expected\ value)^2}{expected\ value}$$

Adding all these together gives the final chi^2 value. Below is the table of chi squared to p-value for 1 degree of freedom. As can be seen to reject the null hypothesis a chi^2 value of at least 3.841 is needed.

P-value	0.5	0.1	0.05	0.02	0.01	0.001
1 degree of freedom	0.455	2.706	3.841	5.412	6.635	10.827

3.6 Existing Examples of Interfaces

During my research periods I looked at existing interfaces similar to those I was aiming to create, or in the same domains. Below I detail some of the examples and the ideas I decided to use for my interfaces.

3.6.1 Website 1
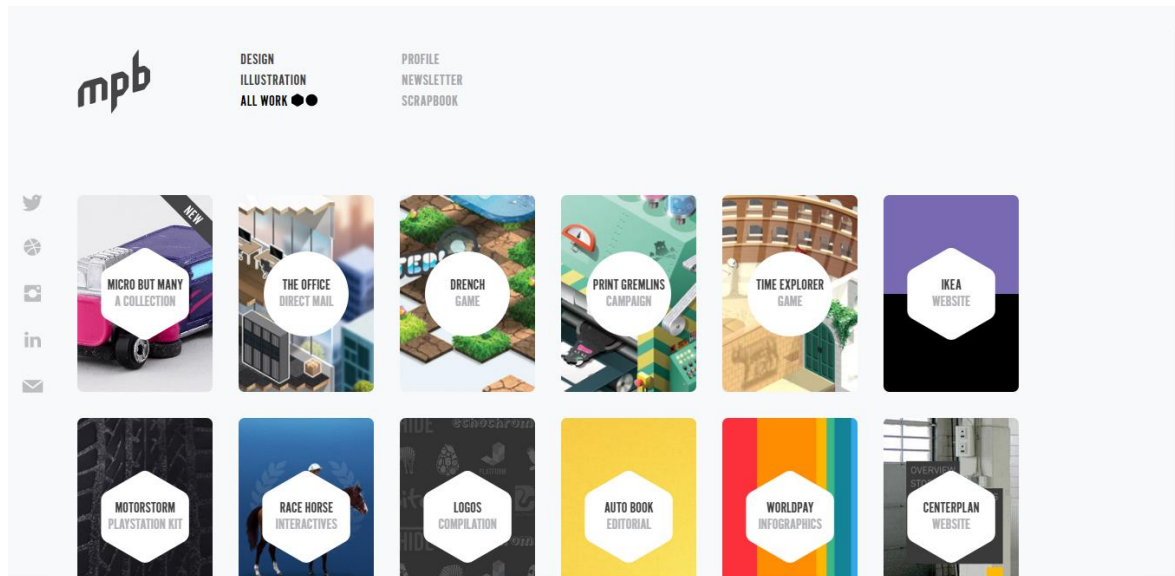
http://www.mypoorbrain.com/

Figure 3.

Use of images with a shape overlay is widely used in the website for displaying text describing what the image links to. This is an idea I would like to incorporate using a hover over effect on images to add interactivity to the website, possibly with an inverse effect of having the image unobstructed before hover.

http://touch-yourself.com/
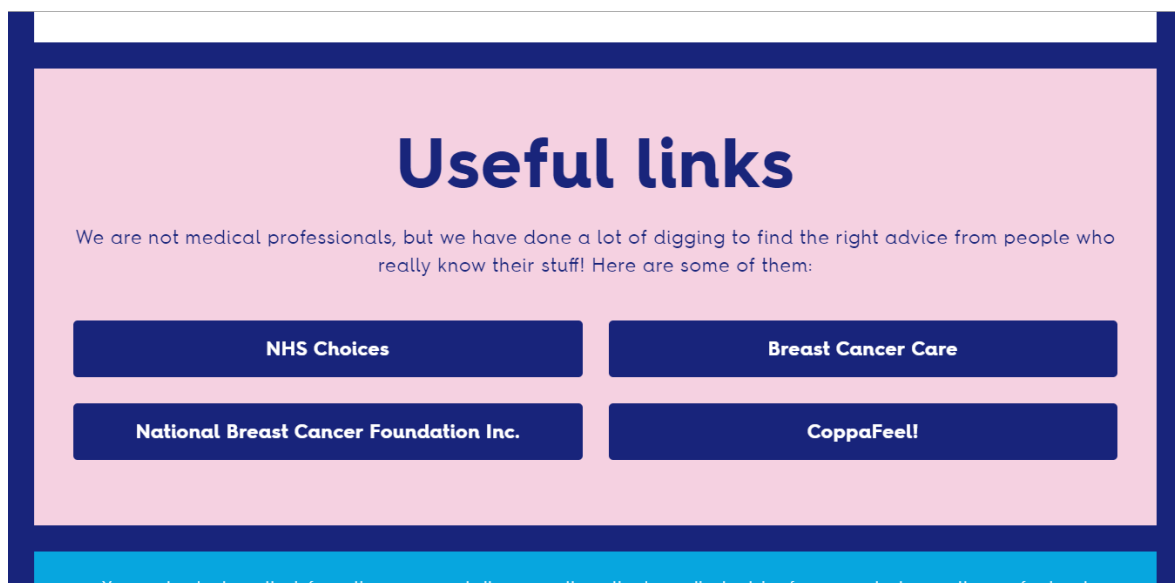
This single page website has clear divisions within the website of different sections. The bold colours and clear-cut squares is stylish and uncommon, the large video at the top of the page is similar to a jumbotron element from bootstrap-based websites which are very common.

https://sites.google.com
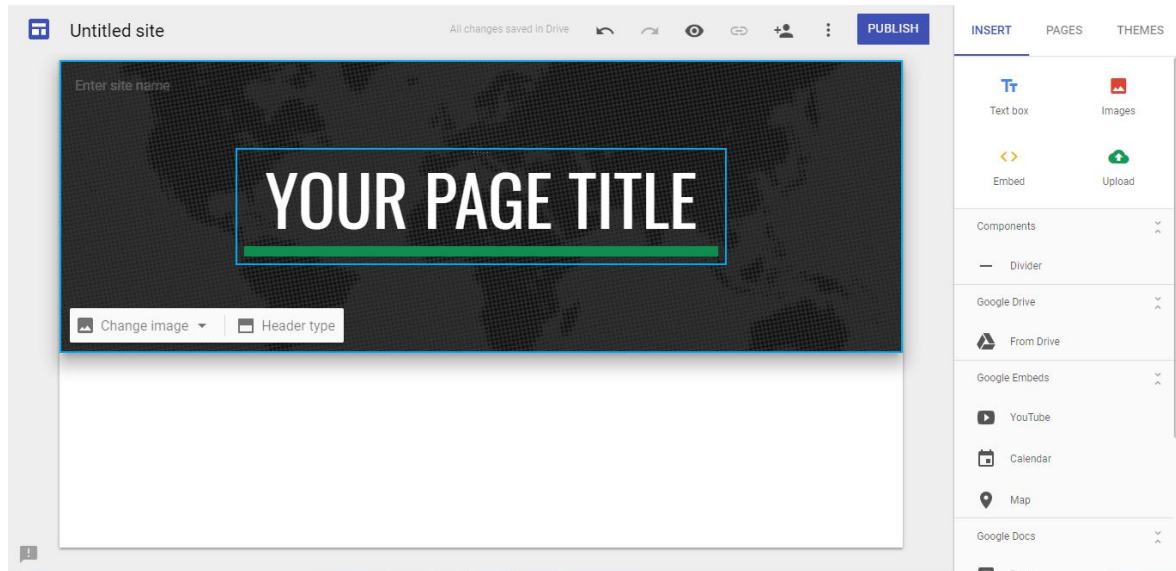
Figure 5.

Google sites was interesting to look at as it has a lot of clear-cut and bold options when making a website. Initially I had thought about using it to create some simple pages for both websites in order to compare a range of styles with simple toggling of elements. This proved to be harder due to having limited options but stylistically gave some ideas.

3.6.2 Website 2

Due to being a business website the feel of it would need to be different, having a more professional tone and I would have less creative input. I discussed with the client the various elements I had seen and wanted to incorporate, however firstly I needed to inspect the existing website.

http://www.purple-services.co.uk/
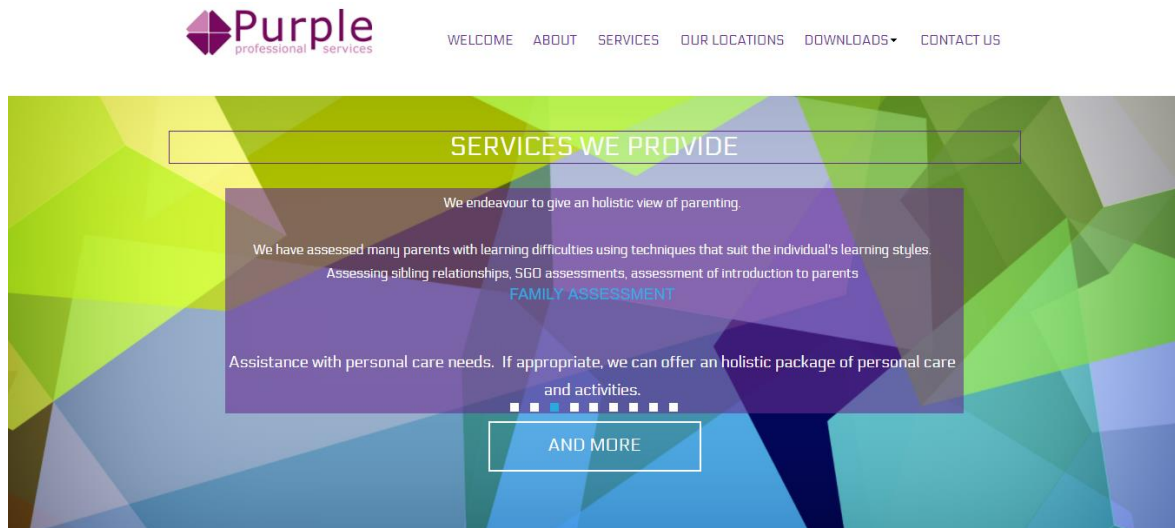
Figure 6.

Several issues were found in the existing site such as broken links, anchored scrolling utilised badly, text too small to easily read, and the mobile view of the website being entirely different with many more issues. Ideally my site will be responsive to avoid the issues with the mobile site of the existing one. The website is also a single page, however due to the amount of content the site would be better split into several pages.

https://www.amazon.co.uk

Figure 7.

Amazon arguably one of the biggest website-based companies and that could be seen as an indicator that they would have a well-designed website including choice of colour usage. The website has a plain appearance outside of the images with only a handful of colours being shown. Whilst aesthetically pleasing the amazon website does not have the navigation that I would ideally like for the business website.

http://www.mainworks-postproduktion.de
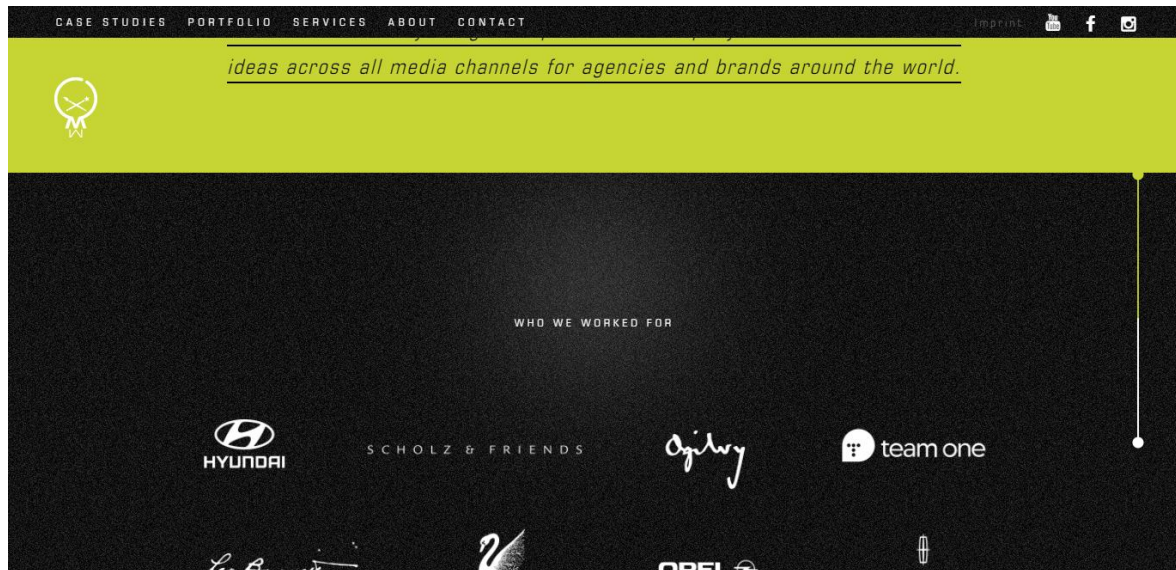
Figure 8.

The Mainworks website has a good navigation feature with an always present scrolling menu. The current page is highlighted with a distinct colour to keep the user knowledgeable about the current state of the website. The website is also well designed for responding to window sizes having the menu collapse into a small icon, easily identified as a menu symbol. A large issue I found with this website when looking at it was the load time, due to a lot of interactivity and fancy animation the website takes up to 30 seconds to load. In my experience the annoyance found with having a long load time is not outweighed by the additional benefits of the animations.

3.6.3 App

The app idea was for a diary/journal, this is a space which many apps currently operate therefore there was a lot of options to take inspiration from.

Journey https://play.google.com/store/apps/details?id=com.journey.app
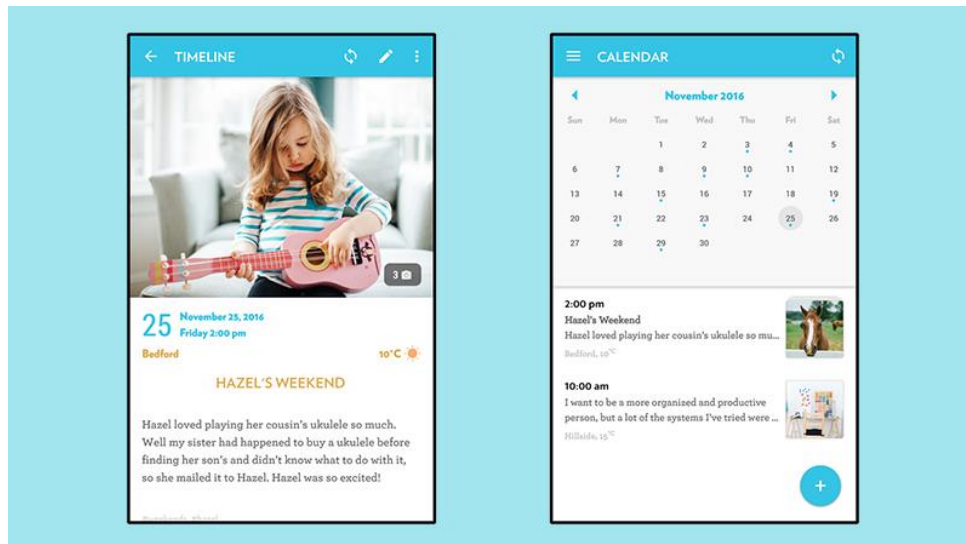
Figure 9.

This app runs on android and is free of cost which could factor into its popularity but also would be fighting for popularity amongst all the other free journal apps. The app has a simple appearance with the android staples of well-known icons and "+" symbol in the bottom right of the screen to add a new entry. Having a calendar view allows the user to easily see dates past, future or present that have entries already. The app also allows users to add images to the entries they make, this is an idea I would have liked to implement at a later stage as an extension task. The app also has extra features, some of which are paid such as night mode with darker screen and weather logging.

Momento https://itunes.apple.com/us/app/momento-private-diary-daily/id980592846?mt=8
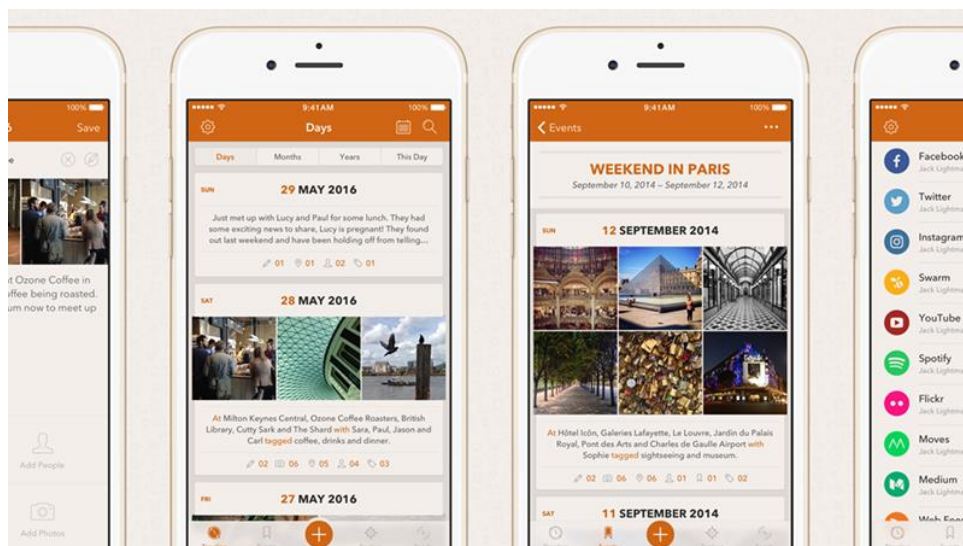
Figure 10.

This app has a reverse chronological view similar to many social networking websites such as Facebook or Tumblr. The bottom toolbar is a common feature in apps, however these buttons can easily be hit on android phones due to the hardware buttons being very close. This is possibly a reason the app is only available on iPhone devices that have limited hardware buttons.

Narrate https://play.google.com/store/apps/details?id=com.datonicgroup.narrate.app
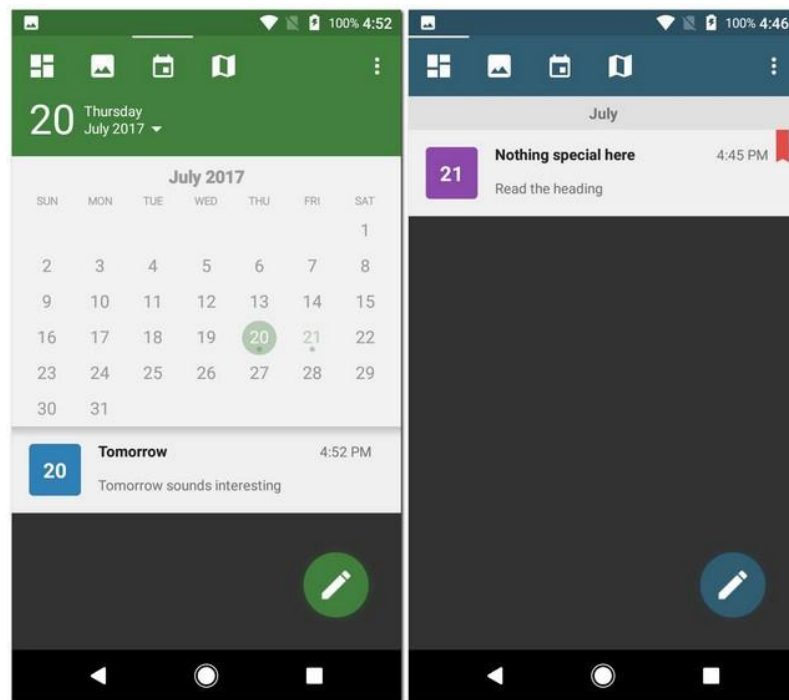
Figure 11.

Narrate is free and has an opensource GitHub repository high in features but lacks aesthetically pleasing interfaces opting instead for default google android styling on the icons, menu bars, and calendar with blank grey backgrounds. The simplicity however is possibly an advantage for usability with easy to see buttons and well known and tested icons being used.

Chapter 4:   **Planning and Timescale**

4.1 Plan

The original plan as shown below was not very detailed at the lower levels but had clear milestones and dates for them to be achieved by.

Start/Prep
18th September -
29th September
- Research HCI issues and effective counters
- Research and learn app development basics in order to produce a HCI interface

Website 1 + 2
30th September -
30th November
- Refamiliarise with html, css, and JavaScript
- Begin work on a simple website, and the small business website
- Isolate HCI issues to study, creating 2 versions of the websites that alter these aspects
- Conduct testing of the 4 versions and process the findings into useable data

Interim Report
1st December
- A few pages of the final report regarding the websites
- Sketches of some designs for the upcoming interface
- Show how the HCI issues in the app might be affected by change
- Intergrate information held in my day book as appropriate

Review Viva
4th-8th December
- Present current work to advisor and viva panel
- Answer questions presented by the pannel to the best of my ability

Application
2nd December -
15th February
- Begin work on a journal application
- Isolate a HCI issue to study, creating multiple versions of the application that alter this
- Conduct testing of different versions and process the findings into useable data

Draft Report
16th February
- Build upon interim report, plan, and diary
- Description of processes, tools, and techniques used to create the software
- Comparison of the produced interfaces and their outcome of their variations during testing
- Intergrate information held in my day book as appropriate

Final Programs and Report
19th February -
23rd March
- As before in the draft report
- Amend any issues raised from draft version, and have programs ready to be submitted

Demo
Summer term 2018
- Present findings of project along side the interfaces created for public display
- Interact and explain the project to viewers and faculty

Figure 12.

4.2 Actual Timescale

4.2.1 Research from 18th-29th September

This goal in the plan was achieved I looked at several existing applications and websites that were in the domain which mine would be operating. I sketched ideas and made note of the aspects I wished to incorporate. 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.

4.2.2 Website 1 and 2 developments from 30th September – 30th January

This goal was partially achieved by December, the first website was complete and ready for testing, however the second website was still under production and awaiting content from the client. The testing of the websites and the completion of the second website was 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 had been completed and will be shown in Fig. 10-11 a later chapter.

4.2.3 Website 1 testing from 10th December – 10th January

Testing of website 1 was completed over December and early January, 28 participants were used, and they provided data after interacting with variant A and B of each website. The website was made available on a laptop, iPhone, android phone and an android tablet which the users could choose from. Statistical tests were run on the data to get confidence values in order to reject the null hypothesis or otherwise.

The quantitative results were analysed statistically and compared to a hypothesis relatively easily. Qualitative feedback was interpreted or converted to quantitative data as best as possible to be compared to the hypothesis.

4.2.4 Application development issues 10th December – 30th December

The IDE of choice for the android application was Android Studio, initially I began work on the App having used the IDE over summer without issue. When I tried to run the built-in emulator that shows the app running Android Studio kept crashing, several re-installs did not remedy this issue, however running the app within Android Studio on other pcs worked but was inconvenient due to not having access to them often. After research I found that it was an issue with my processor drivers and HAXM would also need to be reinstalled. This was a rare issue apparently as searching several FAQ and forum posts found nothing and posting my own questions took several weeks to get a reply.

4.2.5 Website 2 testing from 20th January – 20th February

Over December the small business experienced a high influx of customers causing them to be delayed with providing the content for the otherwise completed website. After waiting for some time for the content and communication resulting in no further content being provided I continued with testing website 2 without the content explaining to participants beforehand that some pages would appear unfinished or duplicates of similar pages. Similarly, to website 1 the testing consisted of 29 participants given the same option of device in which to view the websites.

Additionally, as with website 1 the results were analysed statistically and compared to the hypothesis with qualitative feedback being interpreted and converted to quantitative data as much as possible.

4.2.6 App from 30th December – 33rd March

I aimed to have completed the app by the 15th including testing of the various changes made to the app. That involved building the app from nothing, deciding on the HCI issues specifically to be tested, creating a hypothesis and conducting the testing. Once the data had been collected it would need to be statistically analysed to get meaning from it allowing us to reject the null hypothesis or require further investigation. However, after starting the app proved mare intensive to complete and personal issues slowed my progress greatly. The personal issues have been raised to the relevant parties and will hopefully be resolved soon. As it stands the app is barely started with only a few screens available and no testing carried out on it.

4.3 Plan Projection Alteration

During the projects timeline I had to alter the plan to fit changing circumstances resulting in new plans at certain intervals such as the interim report being presented. Unforeseen events greatly disrupted the original plan, however without such events I believe that the original plan was realistic and achievable.

The act of planning and altering said plan was a valuable lesson throughout the project. If possible, the project would be extended in order to complete the original plans milestones and have more HCI issues identified and resolved.

Chapter 5:   **Software Engineering**

5.1 Repository/Version Control Software

Throughout the project a GitHub repository was used in order to achieve version control, with branches for each aspect of the project. The benefits of such a method are that changes to a single branch cannot affect the other branches or the trunk's health. Branches are merged to the trunk if and only if they are stable. Each branch can have the trunk's changed merged back into it at any point and should be done regularly in order to have the most up to date stable changes. In my case having the repository also allowed me to share with the client for website 2 an up to date copy of the website, however they required assistance in order to access this and I instead would send them a copy of the website via email or show it in person.

5.2 Tools

CASE tools used throughout the project aided and enabled the project. Below I outline some of the tools used such as IDE's, text editors and browsers. Each type of tool was used for a specific purpose enabling the project to advance a stage.

Eclipse was used initially due to being installed prior to the project, it had access to the GitHub repository with a GUI to use for traversing the branches, committing, pushing, and pulling changes. Very occasionally I would use Eclipse for small text editing changes to the project, otherwise I opted for sublime.

Sublime is a free to evaluate, but otherwise paid, text editor that has built in tools to assist with code and markup languages. The appearance is very nice giving the user clear formatting to identify where braces open and close for example, colour coding is also used to quickly scan and see what you want without needing to search for a certain type of syntax used. Overall Sublime accounted for nearly all the text editing within the two websites.

Bootstrap was used as a framework for the website production having several tools available for HTML, CSS, and JavaScript that assist with creation. Bootstrap also has a lot of community driven free to use components such as buttons, image carousels and navigation bars which give inspiration and help when designing the basics of websites.

Firefox, Chrome, and Edge were used during the websites development and testing in order to check there were no issues arising on one of these browsers. Luckily there were limited issues shown during these tests, however with website 2 there was a stand out issue that was resolved with the logo location being altered on Firefox.

Similarly, to above these devices were used during development and testing of the websites: an Android tablet, an iPhone, an Android phone, and a laptop. Their slight changes could have caused issues based on their screen sizes etc. Use of them allowed me to check no unexpected side effects were caused by changes. Use of bootstrap allowed me to make sure the websites were fully responsive, and no issues were noticed.

Android Studio was used as the IDE for the app development, overall it is a very complex IDE, requiring a lot of work in order to get used to many aspects of it. There is a lot of functionality within the IDE that I did not and most likely would not have needed to use during the project. If there was an alternate lighter IDE with less functionality for making Android apps I would have opted to use that instead. The layout editor was very nice to use, and Google have a lot of tutorials to follow in order to create basic apps, and standalone tutorials for more advanced features. Issues

with the emulators caused by HAXM slowed my use of Android Studio, but in the future, I would like to continue learning and produce an app.

5.3 Testing

Black box testing during my development was done partially through checking with the client on possible changes to be made for website 2, and experimentation with participants using the produced websites. Additionally, white box testing was carried out throughout where I would check if the website worked as I had intended and that design changes had been implemented correctly in order to have the desired effect. The majority of my testing however was the usability and acceptance testing mentioned with the client and participants using the website and providing feedback.

Chapter 6:   **Project Development**

6.1 Preparation Work

6.1.1 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.

6.1.2 Planning

Before starting the websites or app, I took a while to put on paper concepts and general ideas for the deliverables (Fig 13.). 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.
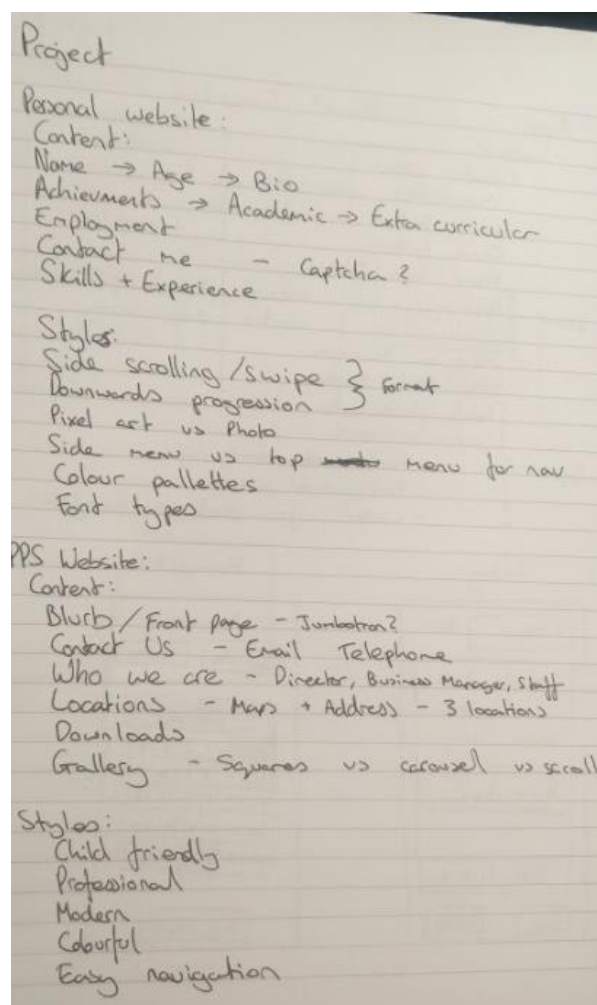

Figure 13.

6.1.3 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.

6.2 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.
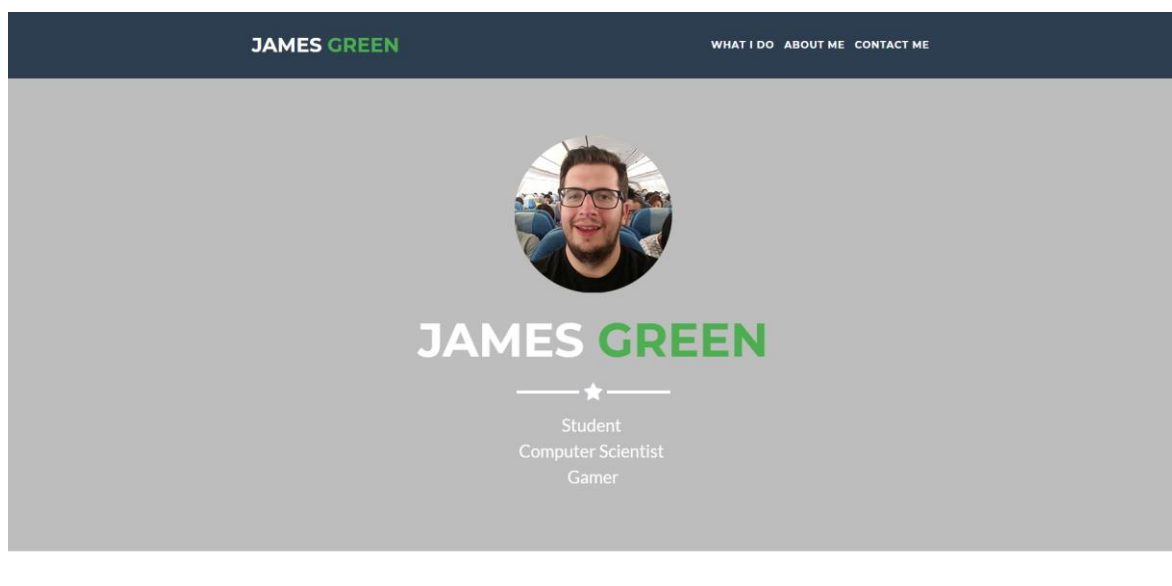

Figure 14.

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.
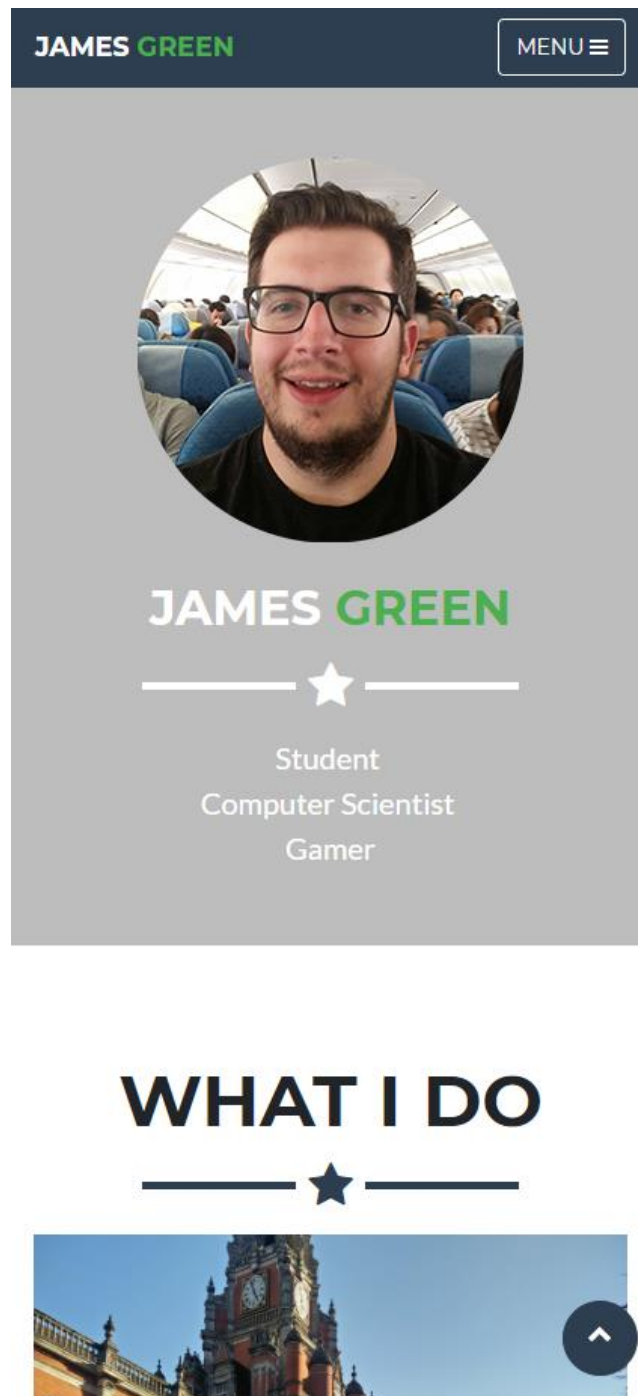
Figure 15.

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.
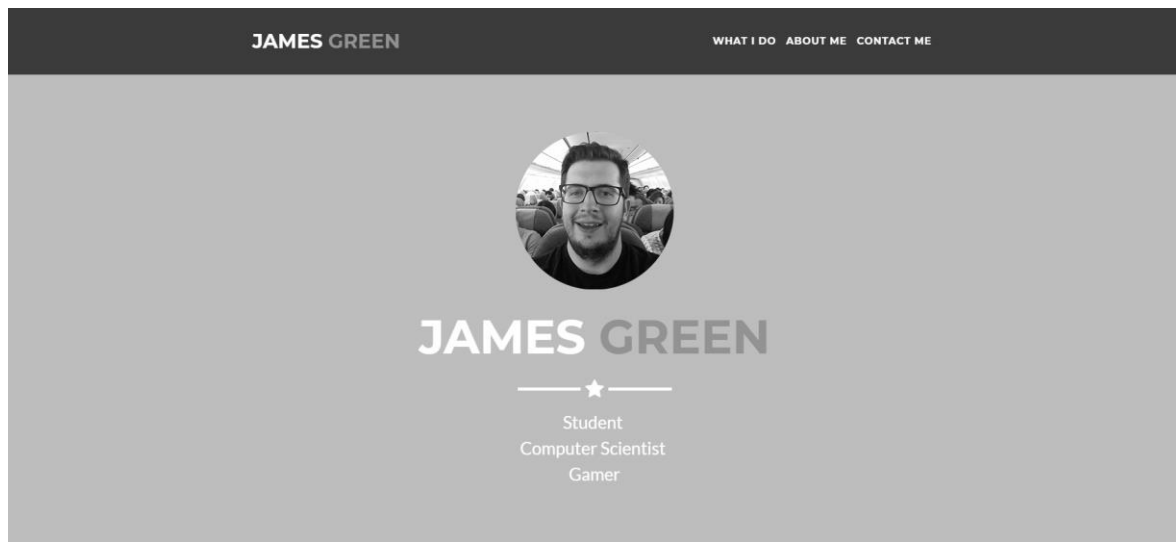
Figure 16.

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 17.

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.

6.3 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.
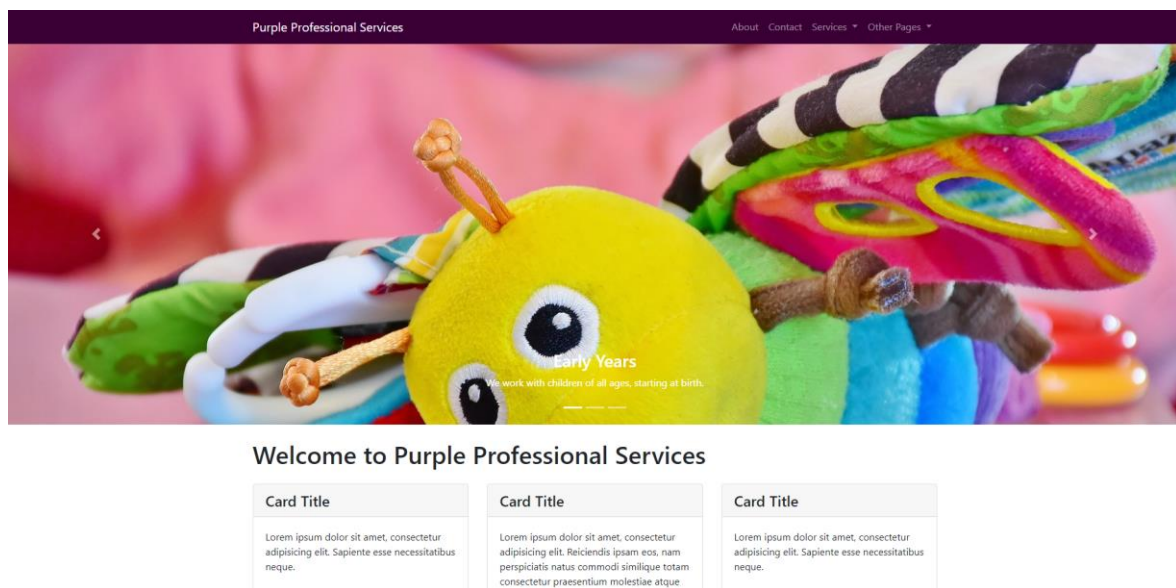

Figure 18.

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.
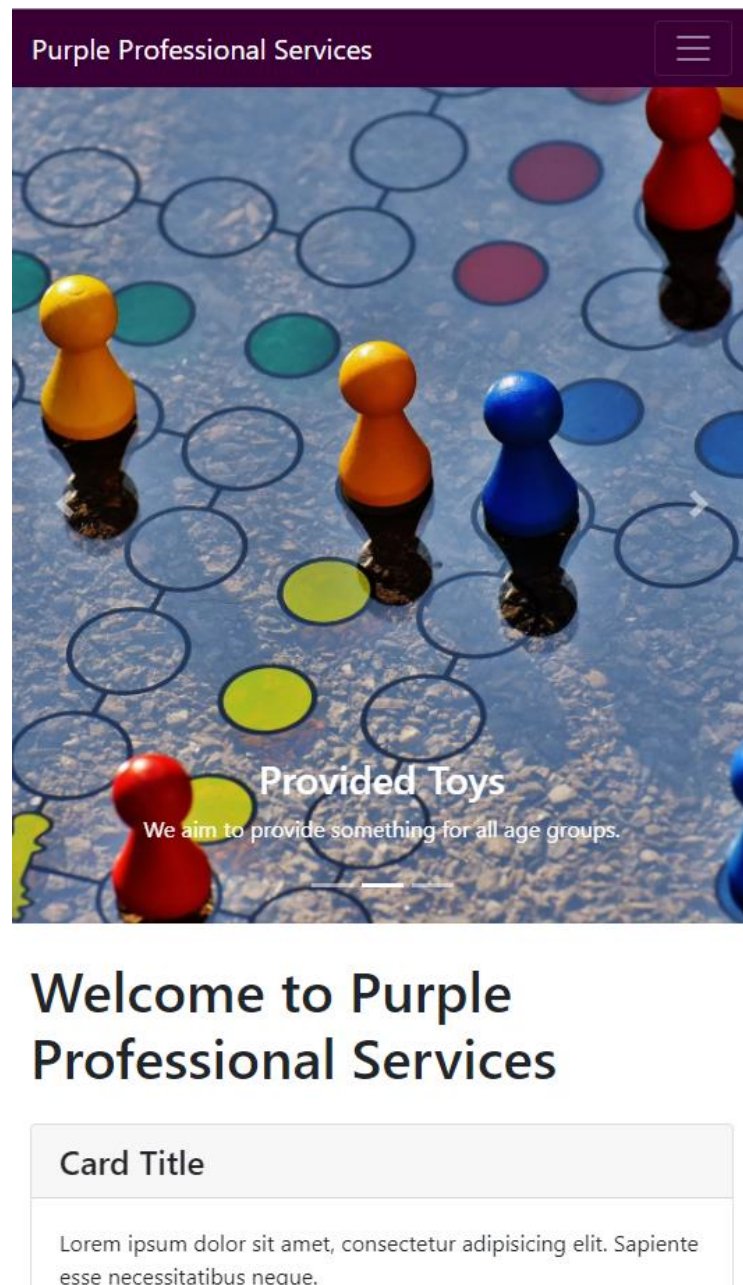
Figure 19.

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.

Throughout development small changes were made and checked with the client such as placement of the logo, layout of the navigation bar, and naming of the individual pages. As can be seen from the following images the content changed towards the end with the logo visible on the main page.

Figure 20.

Logo clearly visible in Figure 20, the only location on the website with the logo due to issues with the logo contrasting against non white backgrounds. Several navigation bars were tried in order to have the logo available, however the client was happy to have the business name present on the navigation bar instead.
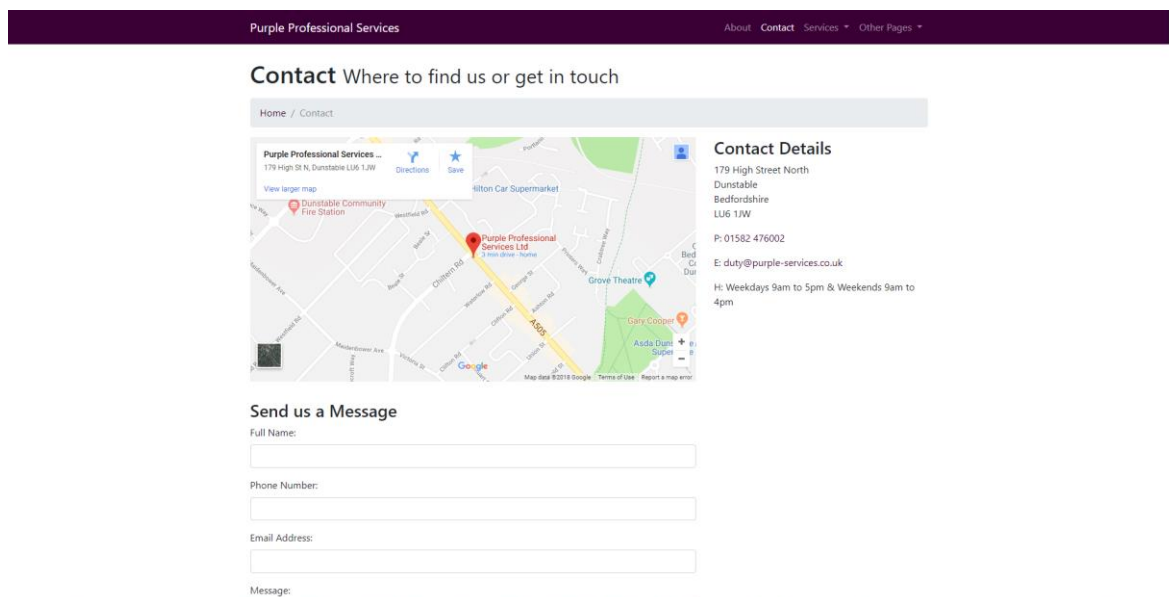

Figure 21.

The contact page allows the user to see the location with google maps embedded into the page, they can also use email and phone links to contact the office. If the user opts for it they can alternatively contact the business through the provided form. This was a feature highly praised from their previous website, although it had issues with visibility.
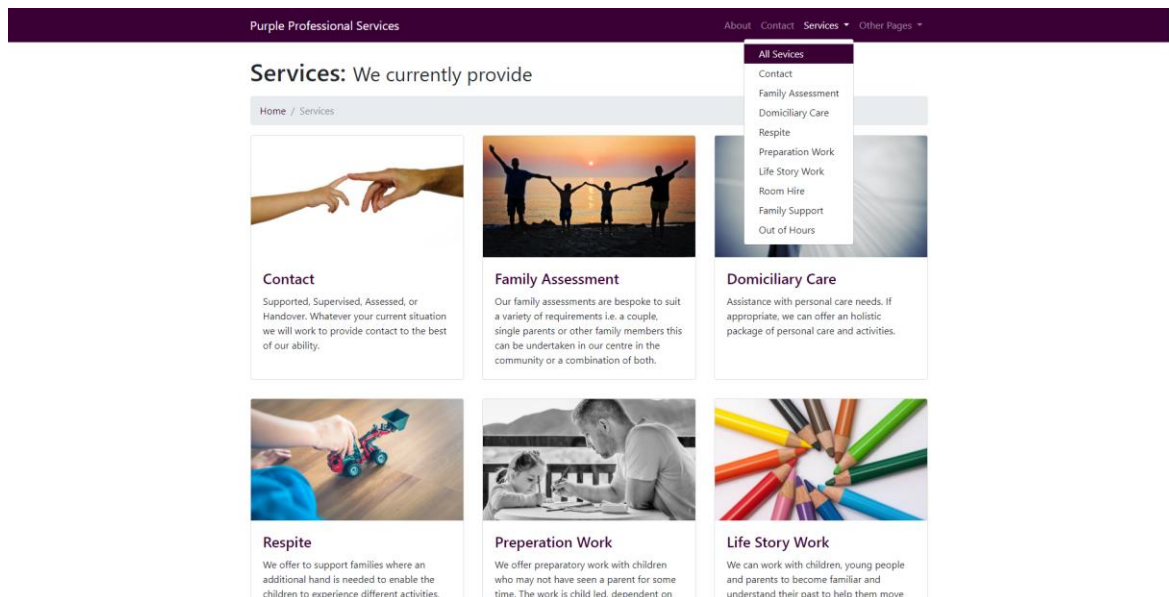
Figure 22.

The services area of the previous website was a troubled area with cramped in words, and a carousel system for displaying the different services. Having a page for the entirety of the provided services and individual pages for the detail of each service allows the user to see and overview or detailed view. The accessability of each page is increased via links in the main page, other service pages and the main services page. Overall the website benefits from a series of short paths where the shortest path from any page to another is very low mostly 1 click without using the navbar, and at most 2 clicks when using only the navbar.

Once the website was complete I proceeded with the greyscale test as done with website 1. As can be seen the test shows the clarity is ok and all elements can be seen and differentiated from other similar ones such as the selected page in the navbar.
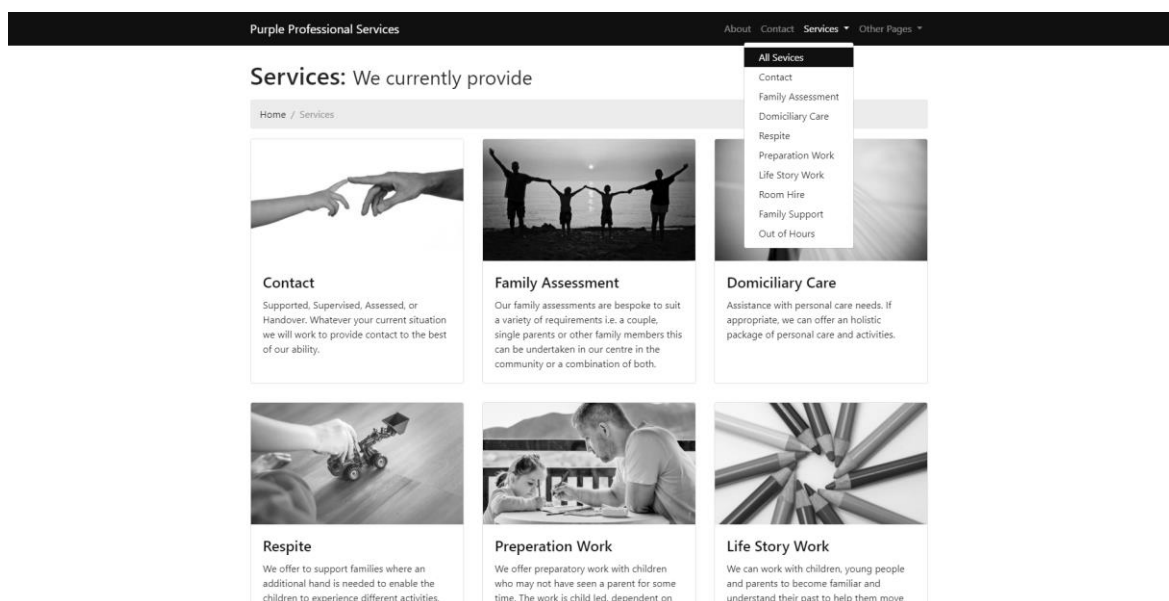
Figure 23.

Several pages still lack content, however testing that was carried out did not rely on content and instead focused on the HCI issues. Once the content is provided the website will be handed over to the client and most likely put to use very soon after.

6.4 Application

Whilst without a computer I continued to work on the project sketching ideas of the app layout (Fig 20-21.). 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.
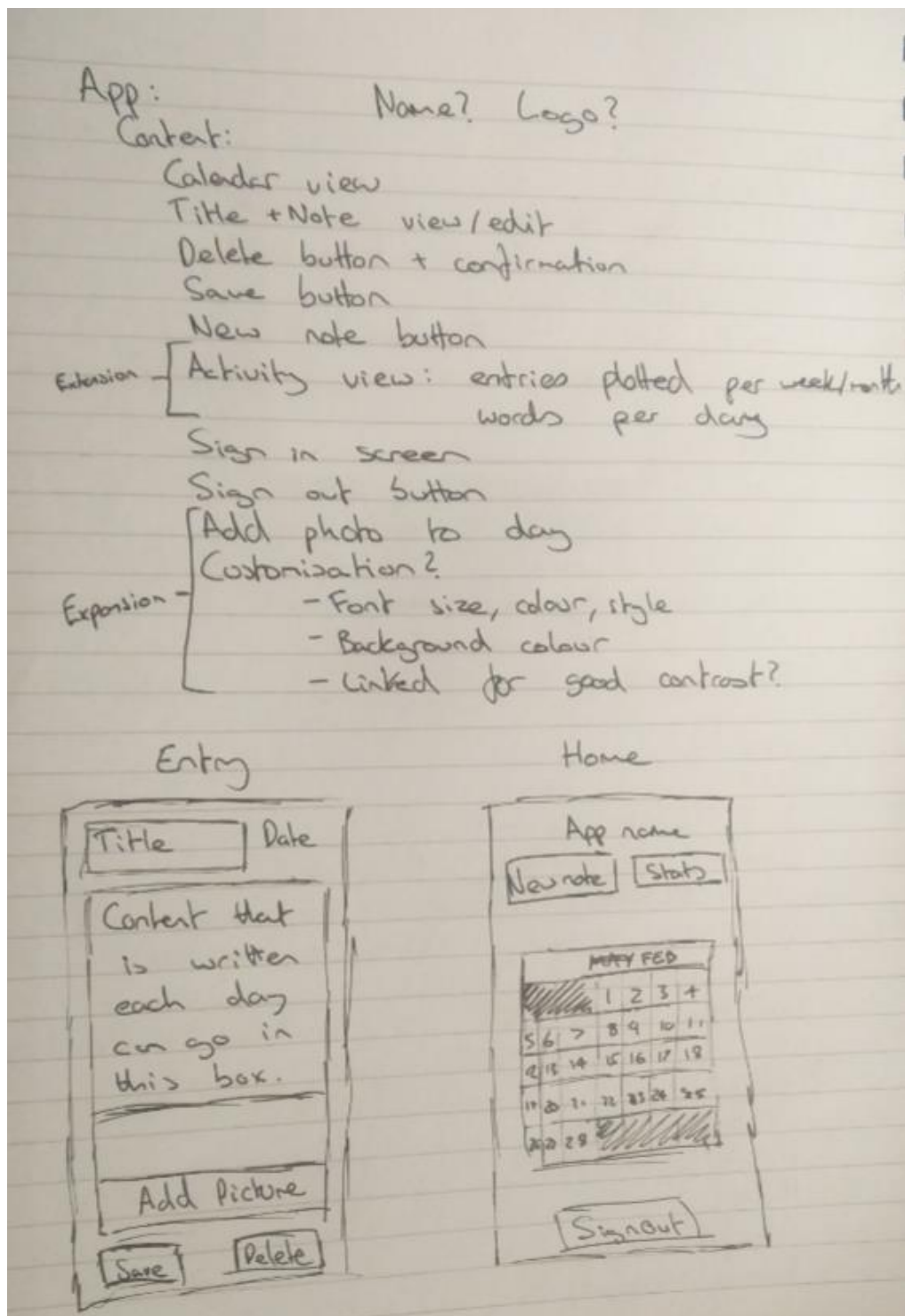
Figure 24.
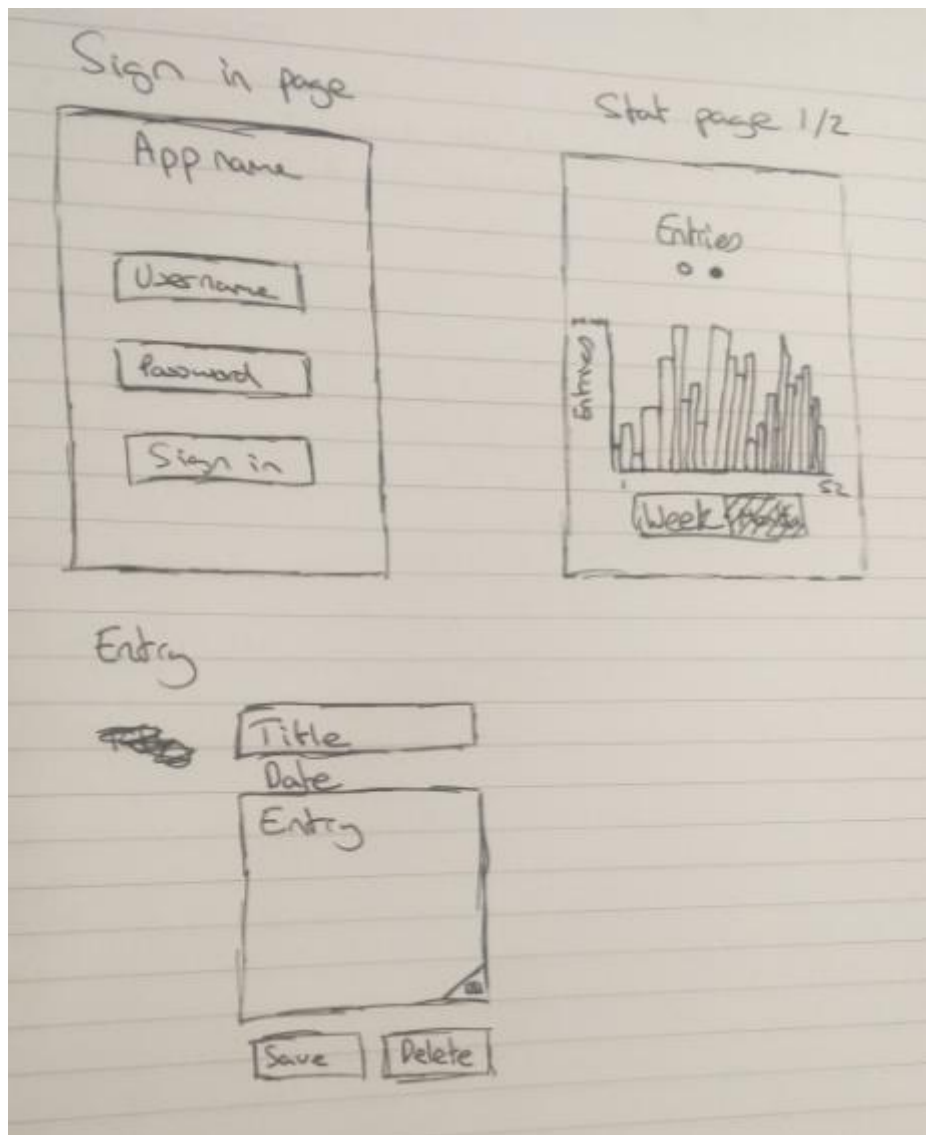
Figure 25.

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.

Development began very badly with an issue within the IDE Android Studio causing a long delay over the Christmas break. Having the issue resolved by early January I began with creating a spash screen with a logo, this was then going to a loginscreen which would be a gateway to the majority of the app.
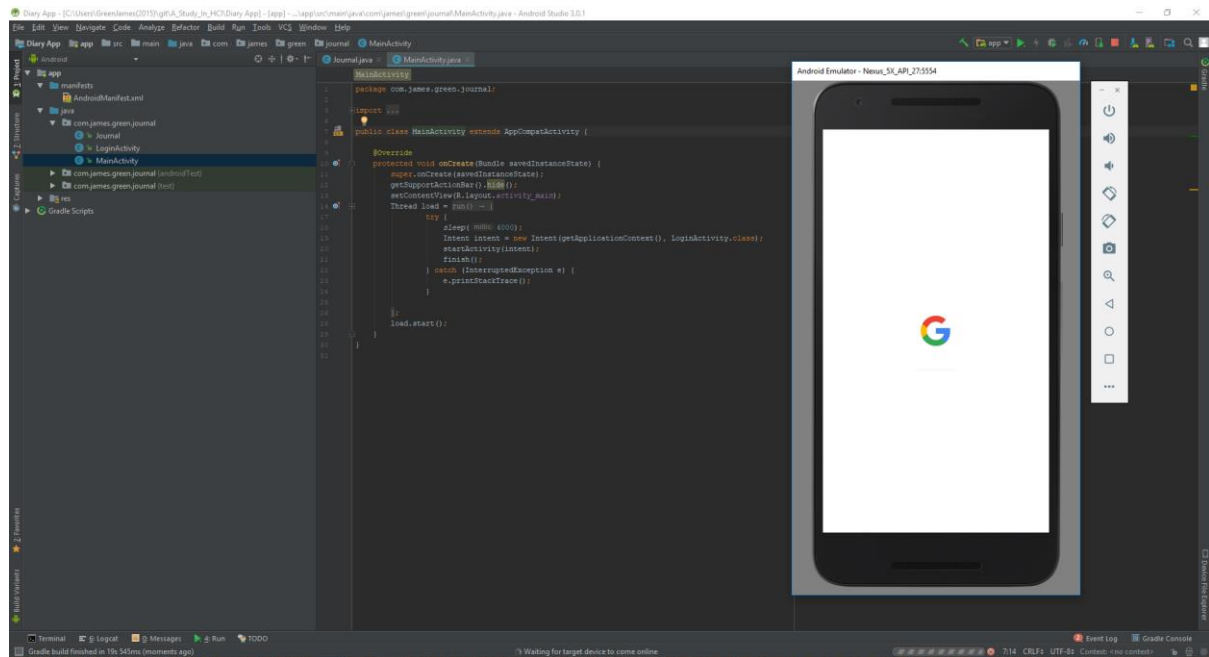
Figure 26.

Using the built in emulator with Android Studio I will show the walk through of the application in its current state.

Figure 27.

As can be seen in Figure 23 the splash screen shows a relevant image for a journal application as well as the logo and app name. This shows briefly before proceeding to the login screen shown below (Fig. 24). Users can then log in with standard convention email and password text entry fields. The password entry obscures the typed in text in the expected fashion. Built in functionality

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with the keyboard allows the user to either click then next textbox/sign in button or to simple hit the return key (bottom right button) in order to progress. In my initial design I had not thought about the placement of the keyboard during the login process, having only half a screen of space limited the options, I opted for a well used google default appearance for the login screen. In the future this may be spaced further apart in order to leave less dead space. The sign in and register button currently does not fit the colour scheme of the app and would also be updated to be the deep red.
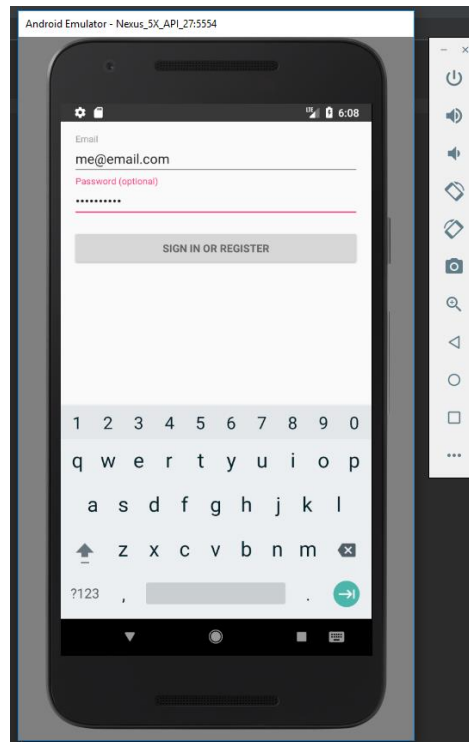
Figure 28.
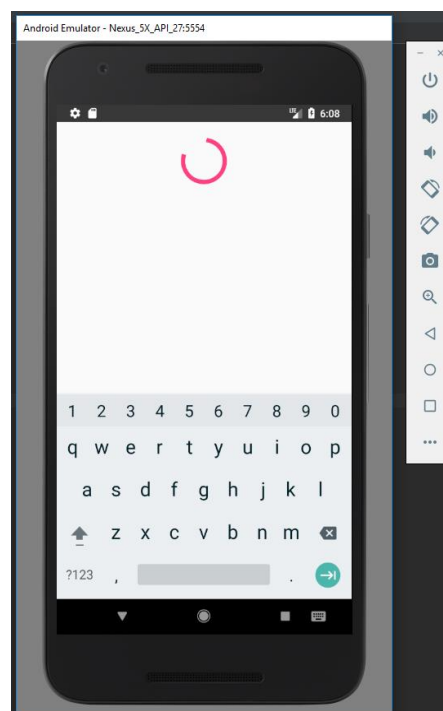
Figure 29.

During the time that the login process is taking place a swirling circle is shown to notify the user that a process is being undertaken and the app has not simply crashed as could be thought of a blank screen. Figure 25 shows this brief scenario occuring before the home screen which Figure 26 would eventually become. You can see in Figure 26 the use of the default colours for the trim around the top edge, and the "+" button.
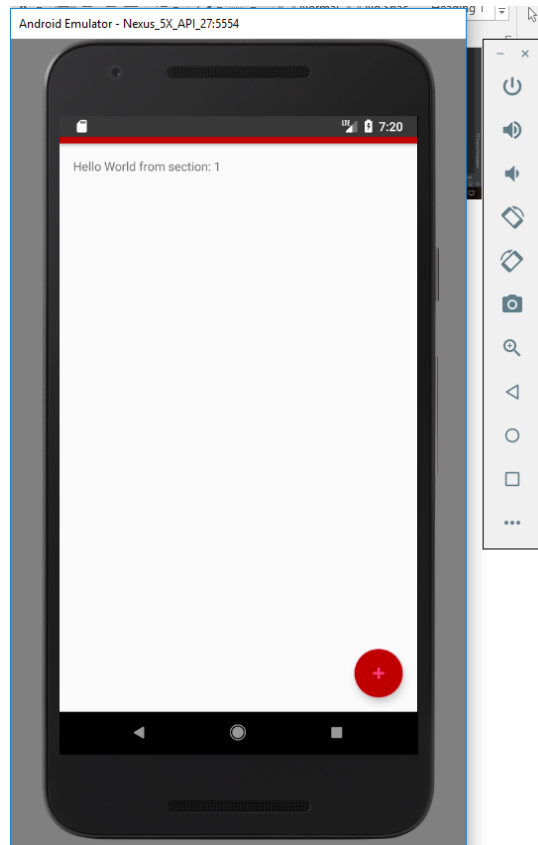
Figure 30.
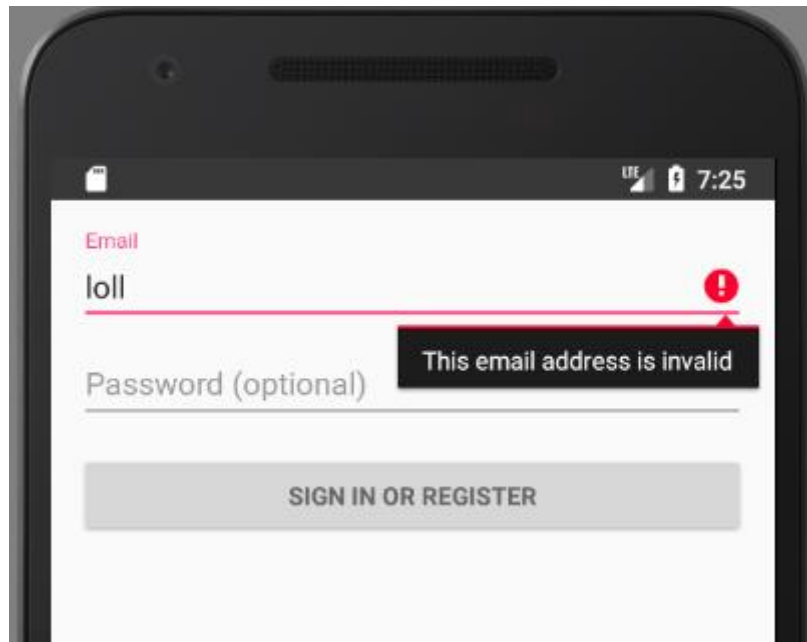
Figure 31.

As can be seen in figures 27 and 28 the login page has some rudimentary feedback for the user to notify them of states where the input values were invalid. These use simple regex to check for "@" and "." in the email and a length longer than 4 characters in the password field. Having a small amount of feedback for the user improves usability through explanation of why they cannot progress rather than them having to work this out themselves.
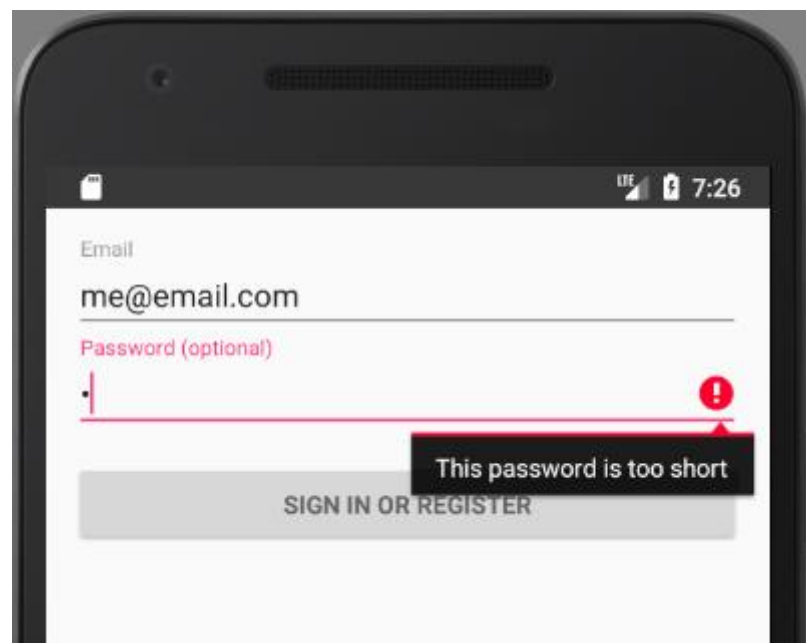
Figure 32.

6.5 Testing

During the winter break testing of the website 1 commenced 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 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 were divided into 2 groups, the first group received the website versions in order A, B. The second group received 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 an option have identifying none of the other options.

The app would 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 would be cyclical if time allowed. 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 22.)
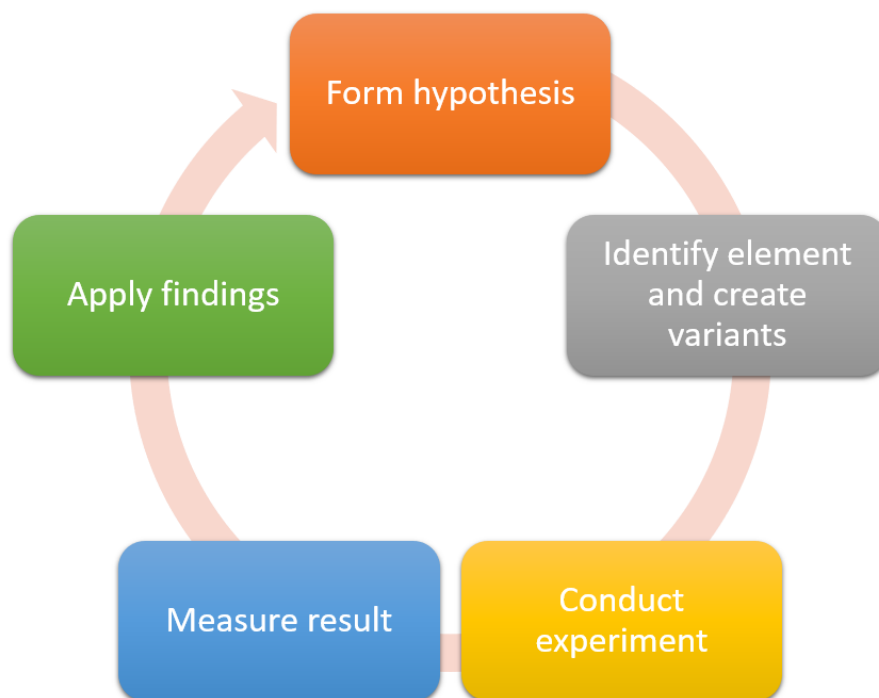
Figure 33.

6.6 Additional Work

6.6.1 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.

6.6.2 Client Interaction

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.

Email contact with the client was our main communication channel however after the first couple of months the amount of replies I received lessened and the content for the website was incomplete, I allowed a couple of months for the content to be sent before continuing to the testing phase with the intention to add content at a later point.

6.6.3 Bootstrap

For both websites Bootstrap was used as a framework, I have become more knowledgeable about Bootstrap throughout the work on both websites and have delved into some of the framework to alter it to my needs. There are several versions of the framework that have some slight differences requiring additional testing and research to achieve some of the goals for both websites.

Chapter 7:   **Testing, Experiments and Results**

7.1 Consent of Participants

During these testing 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. The consent form was built into the form used to collect the data, however prior to their proceeding with the experiment they were presented with an information sheet detailing the project and testing process.

7.2 Website 1 (Personal Website)

7.2.1 Hypotheses

1. User's scoring of the look of the website will decrease as the number of colours in the website decreases.

2. User's scoring of the feel of the website will decrease as the number of colours in the website decreases.

3. User's perception of the monochrome website will be more informal than the original website variant.

4. User's perception of the monochrome website will be less formal than the original website variant.

5. User's perception of the monochrome website will be more relaxing than the original website variant.

6. Users will prefer variant A (colourful) over variant B (monochrome).

7.2.2 Null Hypotheses

1. Variation of the number of colours will have no change to the user's scoring of the look.

2. Variation of the number of colours will have no change to the user's scoring of the feel.

3. Variation of the number of colours will have no change to the user's perception of how informal the website is.

4. Variation of the number of colours will have no change to the user's perception of how formal the website is.

5. Variation of the number of colours will have no change to the user's perception of how relaxing the website is.

6. Users will have no preference of variant.

7.2.3 Method

28 participants, each group having half of the participants within it. Originally 30, however 2 participants could not complete. 14 participants per group.

Using A/B testing with counterbalancing via Latin Squares:

Ordering of variants	Group 1	Group 2
Variant A	1st	2nd
Variant B	2nd	1st

The participants will be given free rein to explore the website with minimal input from experiment team.

After having time with both variants of the website participants will be given a link to the google form to complete (linked below).

The questionnaire will use various question styles such as: Open ended, scalar, multiple choice, and a binary preference question between the two variants.

https://docs.google.com/forms/d/1yuw7G_BgQFirMTbL9MLjB9LryqSRW46cZKWXi9o1XyM/

Additional notes:

At the start of the questionnaire participants agree to: taking place in the study, they have read and understood the participant information sheet (shown in appendix), have had the opportunity to ask questions and had them answered, they have been anonymised and the gathered data can be stored and used for research and they have volunteered with the option to withdraw at any time.

7.2.4 Data

The following contingency tables will be used for chi-squared analysis and the p-value used to possibly reject the null hypothesis.

Variant	# Formal	# Non-Formal	Total
A	21	7	28
B	2	26	28
Total	23	33	56

Variant	# Informal	# Non-Informal	Total
A	2	26	28
B	18	10	28
Total	20	36	56

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Variant	# Relaxing	# Non-Relaxing	Total
A	4	24	28
B	18	10	28
Total	22	34	56

Variant	Preferred	Non-Preferred	Total
A	16	12	28
B	12	16	28
Total	28	28	56

Look

PARTICIPANT	A	B
1	8	8
2	10	6
3	9	8
4	8	7
5	8	7
6	7	8
7	9	8
8	8	7
9	8	5
10	9	9
11	9	9
12	8	7
13	8	9
14	5	8
15	9	8
16	8	9
17	7	6
18	10	10
19	8	8
20	8	5
21	9	8
22	10	8
23	10	10
24	7	9
25	8	7
26	9	9
27	9	4
28	8	10

Feel

PARTICIPANT	A	B
1	7	7
2	10	10
3	10	10
4	7	7
5	7	6
6	7	7
7	8	7
8	8	8
9	8	7
10	9	9
11	9	9
12	9	9
13	9	8
14	10	10
15	10	9
16	10	9
17	10	10
18	10	10
19	8	8
20	9	8
21	10	10
22	10	10
23	10	10
24	7	7
25	8	8
26	9	9
27	9	9
28	10	10

7.2.5 Results

The output of the python program to calculate the chi squared and t-test p values for the data shown above can be seen in figure 34.

```
cim-ts-node-01$ python Chi\ Squared\ Website\ 1.py

Look t-test =
p-value = 0.077

Feel t-test =
p-value = 0.006

Formal chi squared =
p-value 3 = 0.000

Informal chi squared =
p-value = 0.000

Relaxing chi squared =
p-value = 0.000

 Preferred chi squared =
p-value = 0.423
```

Figure 34.

Using a threshold of 95% for significance we can see that the null hypotheses for the feel, formal, informal and relaxing aspects can be rejected do to having well above 95%. The look and preferred significance however do not allow us to reject the null hypothesis. The look was quite close with a 92.3% significance and may require further investigation in order to get more information. The preference of one website over the other was not significant enough to warrant further investigation and it is possible the null hypothesis is indeed correct.

The data strongly supports that:

5. User's scoring of the feel of the website will decrease as the number of colours in the website decreases.

6. User's perception of the monochrome website will be more informal than the original website variant.

7. User's perception of the monochrome website will be less formal than the original website variant.

8. User's perception of the monochrome website will be more relaxing than the original website variant.

7.3 Website 2 (Business Website)

7.3.1 Hypotheses

8. Users will rate the look of variant B higher than variant A.

9. Users will rate the feel of variant B higher than variant A.

10. Users will rate the navigation of variant B higher than variant A.

11. Users will describe variant B as more clean than variant A.

12. Users will describe variant B as more professional than variant A.

13. Users will describe variant B as less messy than variant A.

14. Users will prefer variant B over variant A.

7.3.2 Null Hypotheses

1. The variation will not affect the user's rating of look.

2. The variation will not affect the user's rating of feel.

3. The variation will not affect the user's rating of navigation.

4. The variation will not affect the user's perception of how clean the website is.

5. The variation will not affect the user's perception of how professional the website is.

6. The variation will not affect the user's perception of how messy the website is.

7. Users will not have a preference between the variants.

7.3.3 Method

29 participants, each group having half of the participants within it. One participant did not complete, 1 participant from group 1's data was removed to balance the groups. The last of the group 1 participants was selected. 14 participants per group after adjustment.

Variant A in this test will be the current website found at http://www.purple-services.co.uk/

Using A/B testing with counterbalancing via Latin Squares:

Ordering of variants	Group 1	Group 2
Variant A	1st	2nd
Variant B	2nd	1st

The participants will be given free rein to explore the website with minimal input from experiment team. If they ask for advice on what they should do the suggestion "check the available services and contact them regarding any you choose" will be provided.

After having time with both variants of the website participants will be given a link to the google form to complete (linked below).

The questionnaire will use various question styles such as: Open ended, scalar, multiple choice, and a binary preference question between the two variants.

https://docs.google.com/forms/d/1X2SHttZZxsdtsDNS-YlJLY66zoJJ91xm8WTbUeG8zkM/

Additional notes:

At the start of the questionnaire participants agree to: taking place in the study, they have read and understood the participant information sheet (shown in appendix), have had the opportunity to ask questions and had them answered, they have been anonymised and the gathered data can be stored and used for research and they have volunteered with the option to withdraw at any time.

7.3.4 Data

The following contingency tables will be used for chi-squared analysis and the p-value used to possibly reject the null hypothesis.

Variant	# Professional	# Non-Professional	Total
A	0	28	28
B	24	4	28
Total	25	31	56

Variant	# Clean	# Non-Clean	Total
A	3	25	28
B	21	7	28
Total	25	31	56

Variant	# Messy	# Non-Messy	Total
A	13	15	28
B	0	28	28
Total	13	43	56

Variant	Preferred	Non-Preferred	Total
A	1	27	28
B	27	1	28
Total	28	28	56

The following tables are the collected data that will have t-tests run on them within subject (due to participants feedback for each variant being compared against their own) due to the data being discreet with no chi-squared test being relevant. All the values are between 1 and 10 inclusive.

Look

PARTICIPANT	A	B
1	7	9
2	5	7
3	6	9
4	6	9
5	4	8
6	5	8
7	4	9
8	7	9
9	6	8
10	6	9
11	3	8
12	3	8
13	6	8
14	6	8
15	6	7
16	5	8
17	6	10
18	3	8
19	5	8
20	6	8
21	2	8
22	6	8
23	8	9
24	4	8
25	7	9
26	5	8
27	1	7
28	7	7

Feel

PARTICIPANT	A	B
1	7	9
2	5	7
3	6	9
4	6	9
5	4	8
6	5	8
7	4	9
8	7	9
9	6	8
10	6	9
11	3	8
12	3	8
13	6	8
14	6	8
15	6	7
16	5	8
17	6	10
18	3	8
19	5	8
20	6	8
21	2	8
22	6	8
23	8	9
24	4	8
25	7	9
26	5	8
27	1	7
28	7	7

Feel

Navigation

PARTICIPANT	A	B
1	8	10
2	3	10
3	4	10
4	6	9
5	2	8
6	5	10
7	1	10
8	6	9
9	1	10
10	9	6
11	5	9
12	3	10
13	1	8
14	6	9
15	2	10
16	3	9
17	7	10
18	1	10
19	6	9
20	7	10
21	1	9
22	6	8
23	6	10
24	3	8
25	7	9
26	2	8
27	1	6
28	8	6

7.3.5 Results

The output of the python program to calculate the chi squared and t-test p values for the data shown above can be seen in figure 35.

```
cim-ts-node-01$ python Chi\ Squared\ Website\ 2.py

Look t-test =
p-value = 0.000

Feel t-test =
p-value = 0.000

Navigation t-test =
p-value = 0.000

Professional chi squared =
p-value 3 = 0.000

Clean chi squared =
p-value = 0.000

Messy chi squared =
p-value = 0.000

Preferred chi squared =
p-value = 0.000 _
```

Figure 35.

Using a threshold of 95% significance as with website we can se all 6 null hypotheses can be rejected with confidence levels over 99%. It appears that the changes in the website have had a very significant impact in these areas with a high correlation to change in perception by the users. The collected data strongly supports that:

1. Users will rate the look of variant B higher than variant A.

2. Users will rate the feel of variant B higher than variant A.

3. Users will rate the navigation of variant B higher than variant A.

4. Users will describe variant B as more clean than variant A.

5. Users will describe variant B as more professional than variant A.

6. Users will describe variant B as less messy than variant A.

7. Users will prefer variant B over variant A.

7.4 Visualisations
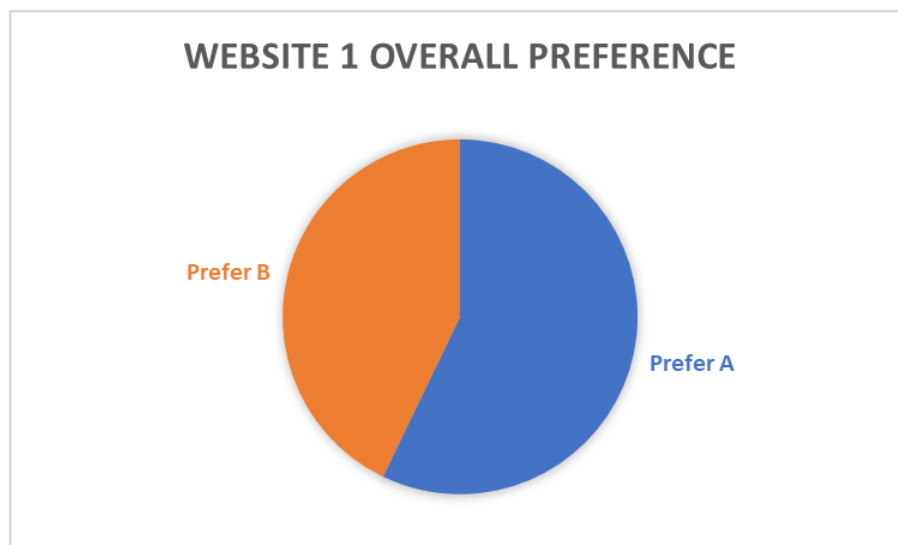
7.4.1 Website 1

Figure 36.

Figure 37.

As the two visualisations above show there was a correlation between how the users perceived the look and feel and how they preferred the websites overall. This could be investigated further in another study to see if look and feel always correlate to overall preference. This clearly shows that whilst the monochromatic change had a big effect on the look as should be expected, the feel of the website was not massively altered. The chart below meanwhile shows that users thought variant A was more formal whilst B was more informal and relaxing, which reflects the results of studies into clothing colour perceptions.
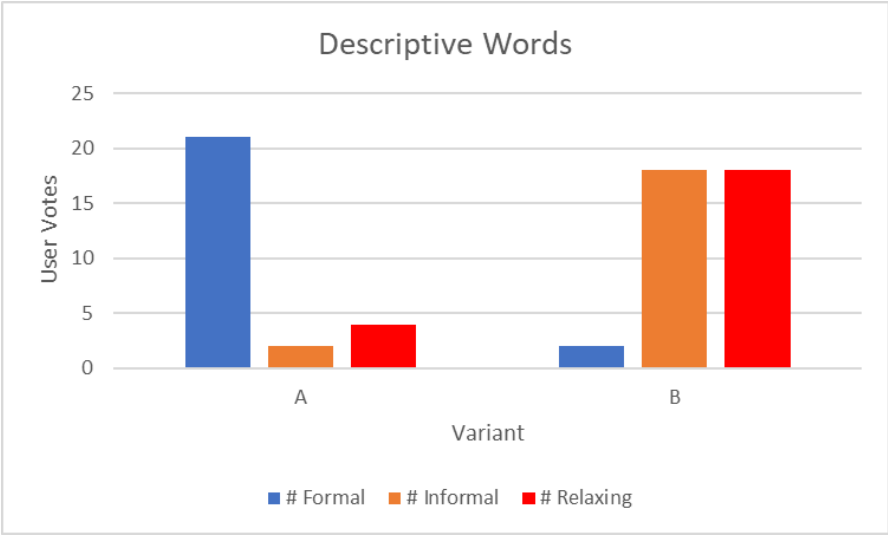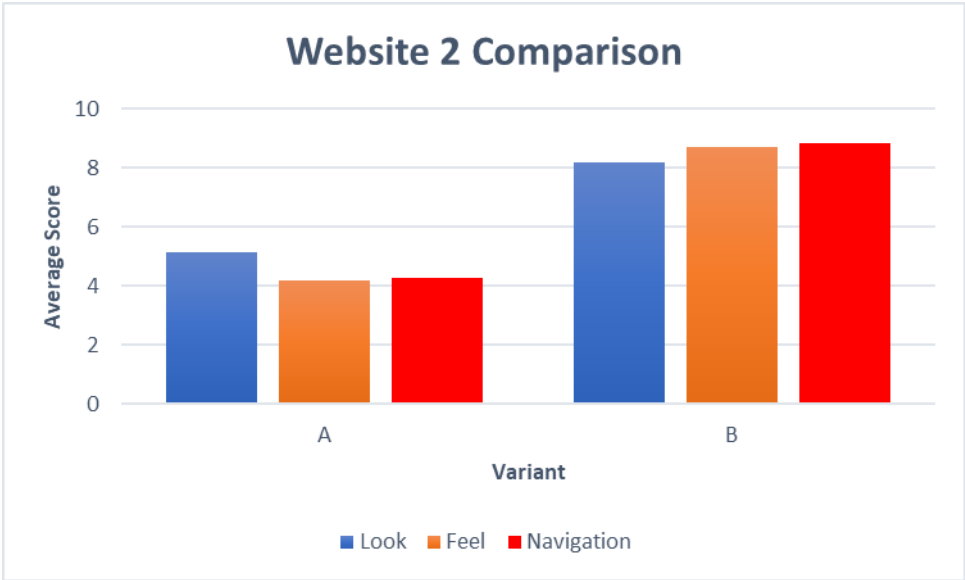
Figure 38.
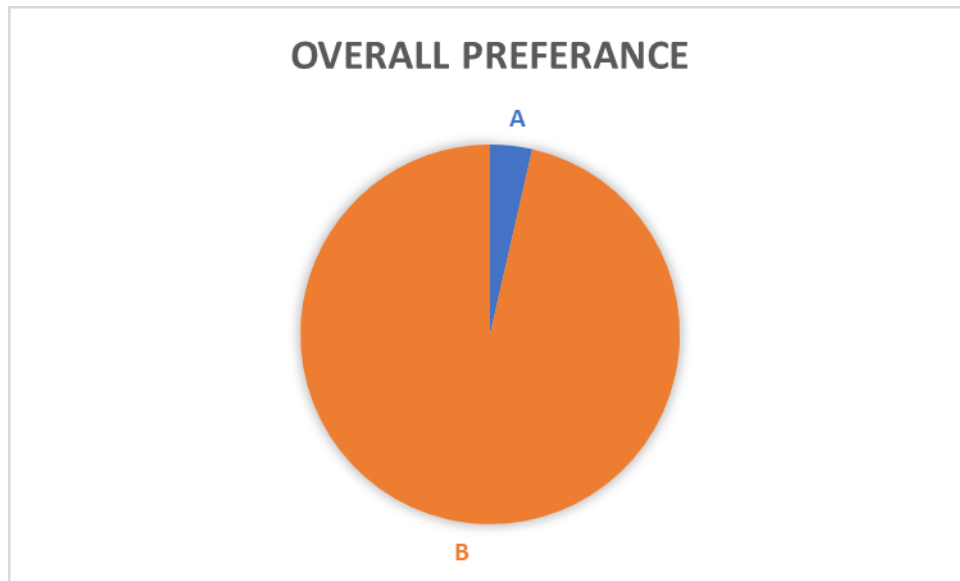
7.4.2 Website 2

Figure 39.

Figure 40.

With website 2 it is even clearer that the effect of look and feel on overall preference has some correlation, it would appear that navigation could also have an effect. The visualisation aims to display the data in a way that is easier to see than the tables and presented p-values. The chart below shows that the new website (Variant B) has a lot more votes for clean and professional as descriptions with no votes for messy, meanwhile the original website has limited clean votes, no professional votes and a handful of messy votes. This shows that the new website received praise within these key descriptive areas when compared to the old one.
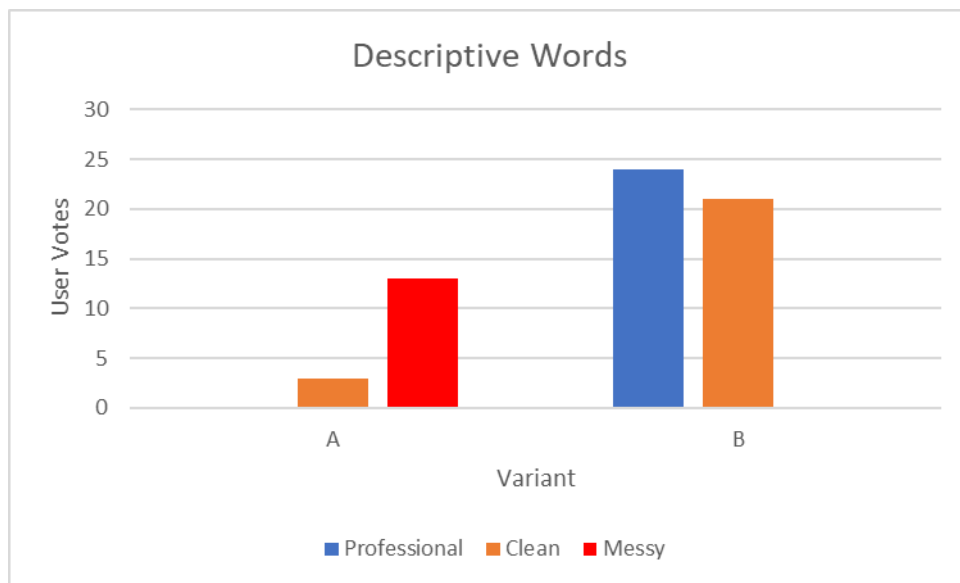

Figure 41.

Chapter 8:   **Self-Evaluation**

8.1 Project Overview

Website 1 and 2 were completed in terms of HCI, having their layout, colour, navigation etc finished with testing carried out upon them, analysis of the data completed, and several null hypotheses disproven. The app was started and had a clear direction to aim for, however several issues caused the sub project to fail, resulting in only a partial app that could not be tested.

8.2 Future of the Project

The project has provided insight into dealing with clients as an individual, and I would like to experience dealing with clients within a business also. The HCI aspects of the project have further reinforced my interest within the industry that connects psychology, biology and computer science together. It is quite likely that where possible I will seek to work within HCI in some way or other.

The business will eventually be using the new website once they provide the last bits of content and want me to remain contactable for any changes they wish to make in the future also. They work with several small businesses who may also be inclined to request my services. Interest from an independent car dealer and a friend who is creating a photography website occurred during the project time, however I requested their patience until summer when my degree will be completed.

The Journal application is currently a task I wish to complete as a personal side project, possibly to keep as a hobby and to be made available on the Google Play Store at a later date. I feel like several HCI issues that are very interesting can be experimented against on the app.

8.3 Successes and Failures

Working with a business proved to be a double-edged sword, having a real-world client was beneficial to see how the process progresses, yet it also delayed any progress due to having to go back and forth for information and approval. Eventually testing was carried out on an unfinished product due to their delay in providing content for their services pages. In a real-world scenario this may have been a different scenario due to there likely being financial investment into the production of the website, the client may have been quicker to reply in order to get a finished product, or I may have been paid upfront so not minded how long content took to be sent over.

The individual website resulted in some building upon the foundations of HCI with comparison between 2 ideas I had entirely created instead of the business website which had been compared to the longstanding current website. The two approaches have similarity and difference resulting in benefits in certain areas towards one or the other.

The individual website could be created however I wanted and other than research into what others had done there would be no bias. Having the existing website for the business however introduced a bias, whether it be to create one as different as possible or to create a better incarnation of it. I opted to vary the website a great deal as I did not like a lot of the existing website, the results show that the new website is preferred over the old one and reinforced my belief.

As mentioned before the app was not completed to a standard that any HCI tests could be completed. An initial issue caused a delay and once it was resolved personal issues had also caused development issues. Development of the application also proved to be a lot more challenging that I

had been expecting. Thorough research delayed progress by weeks, the built-in templates for the various activities were also confusing and required a lot of disassembling to understand what was happening within them.

8.4 Lessons Learnt from the Project

8.4.1 Parallel Sub-projects

The times when I had parallel sub project tasks at the same time were my most productive, having a variety of tasks to choose from instead of sticking to and exhausting myself on a single task proved to increase my morale and subsequently productivity. This is a feature seen in agile methodology, having less linear pathing through the project allows more flexibility and can be adapted to changes in circumstances. During the times I had issues with certain aspects of the project I would have been better to move onto a different aspect whilst trying to resolve the issue in parallel.

8.4.2 Communication

Within any environment communication is usually a necessary skill, as such this project provided ample chances to hone it with a variety of settings.

Communication with my project advisor, client and participants were all very different. I had to adapt to each style with distinct roles within each communication. With the client I was a service provider and it was a professional setting, therefore my tone and writing style was formal, yet I was also seen as the "expert" so was giving in depth description about ideas and implementations. With my project advisor I was still in a semi-formal setting with them taking the role of my boss if it was a work scenario, however after the first few meetings a more relaxed precedent had been set and it was less formal in the following communications. With participants it was a lot less formal having limited time interacting with them, I had a simple cycle with each of them of presenting the websites on their chosen devices and then giving them access to the feedback form. I tried to be approachable in order for them to feel relaxed and able to ask questions they might have,

8.4.3 Time Management

Overall, I had varied time management, when it was good I would be allocating certain times and days to the project without any other tasks being done within these allocated sessions. However, this didn't always work, due to a shifting schedule the sessions also required changes which proved harder to manage during times when there were assignments or personal events occurring. Overall, I think I have learnt that time management needs to be done proactively in order to prevent the occurrence of time gaps where the project was not worked on. Having deadlines with my project advisor could have been beneficial in order to complete milestones on time.

Chapter 9:   **Professional Issues**

9.1 Usability

With any software usability is a key issue that needs to be considered, within HCI it happens to be elevated to possibly the highest of issues we deal with. The effects of usability can be seen everywhere in the world both physical and in the software world. Effects range from simple delays in day to day life to more extreme cases such as the loss of life. I will highlight some real-world cases where usability has failed the user and how such an issue could have been resolved.

A simple, real world example is "9 out of 10 parents install their child's car seat incorrectly" according to New York City Department of Transportation (https://consumerist.com/2011/06/07/9-out-of-10-parents-who-install-car-seats-do-it-wrong/) . This is a simple case of usability failing the user and having possibly life-threatening consequences. The article shown suggests a solution of having an expert inspect the car seat, however this is a clear sign that the usability in unacceptable. It is possible that the car seat is simple to fit correctly, however parents are not given any simple instruction to follow, it is also possible that the car seat does not have a way to display if it has been fitted correctly such as an audible click or a toggle that changes colour shown when locked in. In either case the product requires some change whether it be a physical change or an instruction manual or session that will increase the usability. In software we have the same issue, users may require training in order to use the interfaces correctly or the interface may need to be altered to have more intuitive design.

Here we have a software example of bad usability, sticking to automotive theme, but with less likely life threatening results (https://usabilitygeek.com/jd-power-poor-usability-ford-quality-ratings/). Ford are well known for being a quality mid-range car manufacturer, however their reputation is being tarnished due to poor usability of their centre console operating system. Most likely being used by drivers (people operating heavy machinery) the interface would be expected to be simple and require limited cognitive strain to operate so that the driver can focus on maintaining control of the vehicle. Whilst it is likely a user will simply give up on the operation of the aircon or radio control there is a chance the driver will in fact be distracted and have an incident. In a less extreme setting a user could accidentally cause their suspension to stiffen whilst trying to find the pre-set radio channel editing tool, not a massive issue but the user has not been able to get the desired effect from their interaction. Small annoyances such as this can hugely affect the perception of customers and influence the decision to purchase or not. Losing customers can be a make or break factor for businesses with high value products resulting in less funding for future usability issues or have cuts elsewhere in the production.

In the future the usability issues we face today will be spread more among humans and the interfacing of robotic or other AI sources with the developed interface. This is purely speculation but if there is a scenario regarding a robot using a touch screen interface an issue arises, is it the onus of the robot designers or the interface designers in order to make them compatible? A robot could be given a capacitive touch screen compatible part used to input on a touch screen, there is an enormous range of materials suitable of this task. However alternative methods could be used to ensure robots can interact with the interface, one such example is that internet of things devices are now so commonplace that the robot could likely wirelessly interact via Wi-Fi or Bluetooth connections. Another example of alternate interfaces for robots can be seen in the image above, R2D2 in Star Wars interacts with the Deathstar via "Scomp link" [13] which is an extendable arm the robot uses to interface via port in the wall. A human counterpart is usually seen interacting with buttons, dials and monitors.

Lastly a core aspect of usability is that it is a very individual subjective measure. What a single user may consider as high usability can also be measured by a different individual as a very low amount of usability. I suffer from red-green colour blindness and enjoy video games, what I consider to be a highly usable user interface within a game may well be considered very hard to use by a player who suffers from a different form of colour blindness, or even a more extreme red-green colour blindness. This is just one such example where a small amount of the population will find the interface extremely hard to use due to colour. However, we can also look at it with regards to written and spoken language, if the user does not understand the chosen language they will not be able to use the otherwise well-designed interface unless there is a method outside of this for them to receive information. In a well-designed interface there is usually clues outside of language for the user to complete their desired tasks without requiring reading, examples of this can be seen in places such as airports and train stations. The design on the interface will usually have a pictorial element that represents the language equivalent, an exception to this is numbers as Arabic numerals are widely known and used.

When implementing any interface, it is best to take all of the above issues into account and to test adequately in order to achieve as much usability as possible for the widest array of users possible. Like utilitarianism we strive for the maximum good for the maximum amount of people, where the good is usability and the people are users.

Bibliography

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

> Nielsen Norman Group website is full of interesting articles which shared HCI
> knowledge and opinions in interesting format. Nielsen is of course known well for
> his heuristics for user interfaces, their colleagues who provide articles also well
> renowned. Use of this website can be done during travel quite easily to read near
> daily updates via mobile browser. In particular, the heuristics page was helpful as
> reference to the core of usability.

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

> It is important to look at alternative approaches in most aspects of life and the
> project as a whole, Gerhardt-Powals alternatives to the widely used Nielsen
> heuristics was the alternative I chose to inspect. Ultimately both are useful sources
> of heuristics or principles.

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

> As with Nielsen's Heuristics Schneiderman's 8 golden rules are also widely known
> and used within HCI. The golden rules aim to improve interfaces in the same ways
> that the heuristics do.

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

> This book covers all the basics of HCI with more detail, ready and waiting, this
> will be my main textbook for reference throughout the project. I can search
> through the basics and then delve deeper once I locate an area of HCI that I require
> further exploration of.

[5] Interaction Design Foundation, *Fitts's Law: The Importance of Size and Distance in UI
Design* https://www.interaction-design.org/literature/article/fitts-s-law-the-importance-of-
size-and-distance-in-ui-design , as of January, 2018

> Interaction Design Foundation explain Fitts's law well and has images detailing
> the law in effect such as button size and edge placement.

[6] Optimizely, *Optimization Glossary – A/B Testing*
https://www.optimizely.com/optimization-glossary/ab-testing/?redir=uk, as of January,
2018

> Optimizely illustrates the A/B testing method greatly in this article with several
> other optimization terms described in the glossary. This article in particular was
> the best simple terms description of the method whilst still having some depth to it.

[7] Martyn Shuttleworth. *Counterbalanced Measures Design.* Explorable.com:
https://explorable.com/counterbalanced-measures-design May 8, 2009

Explorable shows the counterbalancing method used during my project, it also has graphics to show the process for more variants if this was part of the project one of these Latin square layouts would likely have been used.

[8] Donald A. Norman, *The Design of Everyday Things Revised and Expanded Edition*, 2013, Cambridge Massachusetts, The MIT Press.

This was a book recommended by two professors who teaches HCI at Royal Holloway. It serves much the same as the following website, it covers some of the topics of the course I attended, acting as a point of reference to check back upon. The writing in this book is also easier to read and deals with interaction outside of just HCI giving it wider application.

[9] Nuno Barreiro & Carlos Matos, *16-17 CS2846: Human-Computer Interaction*, Royal Holloway University of London, https://moodle1617.royalholloway.ac.uk/course/view.php?id=3902 , 29/09/2017

In my second year of undergraduate study I took this class and learnt nearly all I went into this project with regarding HCI. I decided it would be beneficial to keep it at hand for checking back to keep on track with the core of HCI.

[10]   Color Matters, J.L.Morton, https://www.colormatters.com/ , 29/09/2017

This website proves to be useful for colour theory in various views, such as marketing and scientific. A simple but effective website with many pages of information that was easy to digest.

[11]   Awwwards, https://www.awwwards.com , 12/03/2018

This site gives daily awards to websites that excel at design, innovation or creativity and has yearly and monthly awards too. Each website featured is given 4 ratings that are based on a 10 point scoring system. The overall rating is biased towards design and usability. Scores are collected from a panel of experts and distinct categories are available such as mobile sites. When looking for inspiration this is one of the sites I used to find excellent design.

[12]   Gizmodo Field Guide, *The Best Journaling Apps to Record Your 2017 Memories*, https://fieldguide.gizmodo.com/the-best-journaling-apps-to-record-your-2017-memories-1790359047 , 12/03/2018

This article illustrated their top 5 apps within the journal/diary domain with images showing their mane screens. I used this for getting inspiration for the app layout and design.

[13]   Wookieepedia, *Scomp link*, http://starwars.wikia.com/wiki/Scomp_link , 18/03/2018

This wiki entry shows a possible alternate interface for robots. Several Sci-Fi technological advancements have been seen to come true years after their original conceptualisation. Such examples are: the replicators from Star Trek with the real-world counterpart being the 3D printer, or The Jetsons cartoon having a robotic vacuum cleaner and the modern real world robotic vacuum cleaner being the Roomba.

[14]   Sheffield University, Participant Information Sheet, https://www.sheffield.ac.uk/polopoly_fs/1.401722!/file/InformationSheet.pdf, 21/03/2018

This was the basis of my participant information sheet, being used by a highly regarded university with it available for academic purposes suited the needs of this study perfectly.

[15]		Pexels, Royalty Free Images, https://www.pexels.com/royalty-free-images/ ,
	21/03/2018

[16]		Pixabar, https://pixabay.com/ , 21/03/2018

[17]		Unsplash, https://unsplash.com/ , 21/03/2018

The last 3 entries in the bibliography provided images used in all 3 of the subprojects allowing use under the Creative Commons CC0 licence which can be seen at https://creativecommons.org/publicdomain/zero/1.0/deed.en. In the case of Pexels only certain images were covered under CC0 and I made sure to check before using it within any work I carried out.

Appendix

Submission Directory Layout

A_Study_In_HCI

- Diary App (Android Studio project layout within)

- Paperwork

    o Final Report (final report and drafts)

    o Testing (all files associated with testing carried out)

    o Initial Paperwork (provided paperwork at start of project)

    o Interim (interim report, plan and viva)

- Website 1

    o Personal Website (all files and folders for the personal website)

    o Personal Website – Alt (all files and folders for the alternate version)

    o Personal Website – Greyscale (all files and folders for the greyscale version)

- Website 2

    o Purple Website (all files and folders for the personal website)

    o Purple Website – Greyscale (all files and folders for the greyscale version)

- README.md

- README.txt

Repository

https://github.com/zbvc216/A_Study_In_HCI

Diary

March 27, 2018

Project ready for submission, report completed, and other files collected into a directory.

March 20, 2018

Report continued with professional issues section completed.

March 16, 2018

Met with Greg for final meeting to discuss project submission, current state of report and how marking will be carried out.

March 8, 2018

Additions to draft added and sent to Gregory for comment in next meeting.

March 1, 2018

Analysis of website 2 data started.

February 24, 2018

Continued work on app login page and transition from splash screen.

February 20, 2018

29 participants completed website 2 testing. 1 dropped out, will delete last of the participants data that was from the opposite group in order to balance group sizes.

February 15, 2018

Majority of the 30 participants for website 2 have completed the testing.

February 14, 2018

Met with Gregory to discuss project report/draft.

February 8, 2018

Work on application continuing, working on login page.

January 28, 2018

16 participants completed website 2 testing.

January 28, 2018

App development started with splash screen completed.

January 20, 2018

First participants of website 2 testing have completed the experiment.

January 15, 2018

Started statistical analysis of website 1 data. Testing of website 2 will commence soon due to lack of content being sent by the small business.

January 10, 2018

Met with Gregory to discuss the project progress made so far and get feedback on interim review.

January 10, 2018

All test data for website 1 collected, 28 participants completed total. 2 dropped out from the original 30.

January 2, 2018

Android studio issue fixed, HAXM issue was identified and solved. Work can continue now with the development.

December 20, 2017

Issue with android studio causing delays in project work.

December 20, 2017

Continued testing of website 1, 20 participants completed.

December 12, 2017

Started work on app, android studio updated, and some basic images collected for use.

December 12, 2017

Began testing of website 1, 6 participants completed.

December 5, 2017

Presented project progress to Carlos, saw other projects also

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.

November 22, 2017

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

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.

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.

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,

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

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.

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.

October 26, 2017

Sent initial design options to business for thoughts on overall design

October 19, 2017

Hierarchical task analysis of the app

October 10, 2017

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

October 10, 2017

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

Participant Information Sheet

1. Research Project Title: A Study in HCI (Human Computer Interaction)

2. Invitation You are being invited to take part in this research project. Before you decide to do so, it is important you understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether you wish to take part. Thank you for reading this.

3. What is the project's purpose? This research project aims to investigate how alterations within websites and apps affect user perception of the website or application. The project is a final year project in computer science from Royal Holloway University of London that was chosen by the student.

4. Why have I been chosen? You have been chosen at random to represent a wide demographic that could use the website once completed.

5. Do I have to take part? It is up to you to decide whether to take part. If you do decide to take part, you will be able to keep a copy of this information sheet and you should indicate your agreement to the online consent form. You can still withdraw at any time. You do not have to give a reason.

6. What will happen to me if I take part? You will be asked to complete a web-based questionnaire which we estimate will take you 10 minutes. You can also ask questions throughout your participation or afterwards.

7. What do I have to do? Please spend a few minutes exploring two variants of the same webpage before proceeding to the form for feedback. Please answer the questions in the form to provide us with feedback. There are no other commitments associated with participating.

8. What are the possible disadvantages and risks of taking part? Participating in the research is not anticipated to cause you any disadvantages or discomfort. The potential physical and/or psychological harm or distress will be the same as any experienced in everyday life.

9. What are the possible benefits of taking part? Whilst there are no benefits directly to yourself for taking part, you will be greatly helping the research to progress. This is a learning based research and as such you will be participating in a learning exercise to further the understanding of HCI.

10. What happens if the research study stops earlier than expected? Should the research stop earlier than planned and you are affected in any way we will tell you and explain why. At this point you will be free to withdraw should you wish to.

11. What if something goes wrong? If you have any complaints about the project in the first instance you can contact researcher. If you feel your complaint has not been handled to your satisfaction you can contact the Royal Holloway Computer Science department (information listed below).

12. Will my taking part in this project be kept confidential? All the information that we collect about you during the research will be kept strictly confidential. You will not be able to be identified or identifiable in any reports or publications. Any data collected about you in the online questionnaire will be stored online in a form protected by passwords and other relevant security processes and technologies. Data collected may be shared in an anonymised form to allow reuse by the researcher. These anonymised data will not allow any individuals or their institutions to be identified or identifiable.

13. Will I be recorded, and how will the recorded media be used? You will not be recorded in any way other than your input to the questionnaire.

14. What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives? The questionnaire form will require input regarding your opinions of the websites you will have been shown and interacted with.

15. What will happen to the results of the research project? Results of the research will be evaluated and compared to hypotheses and a report will be submitted to the Royal Holloway Computer Science department. You will not be identified in any report. If you wish to be given a copy of any report resulting from the project, please provide us with your email address before departing.

16. Who is organising and funding the research? This project is organised by James Green a student at Royal Holloway studying Computer Science. The project is not funded in any way.

17. Contacts for further information:

  Researcher
  James Green
  james.lloyd.green@gmail.com
  07590323221

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  TW20 0EX
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Chi Squared and T-test code

Website 1

```
import scipy.stats as stats


print '\nLook t-test ='
a = [8,10,9,8,8,7,9,8,8,9,9,8,8,5,9,8,7,10,8,8,9,10,10,7,8,9,9,8]
b = [8,6,8,7,7,8,8,7,5,9,9,7,9,8,8,9,6,10,8,5,8,8,10,9,7,9,4,10]
tStatistic, pValue = stats.ttest_rel(a,b)
print 'p-value =', ("{0:.3f}".format(pValue))

print '\nFeel t-test ='
a = [7,10,10,7,7,7,8,8,8,9,9,9,9,10,10,10,10,10,8,9,10,10,10,7,8,9,9,10]
b = [7,10,10,7,6,7,7,8,7,9,9,9,8,10,9,9,10,10,8,8,10,10,10,7,8,9,9,10]
tStatistic, pValue = stats.ttest_rel(a,b)
print 'p-value =', ("{0:.3f}".format(pValue))

print '\nFormal chi squared ='
a = [21, 7]
b = [2, 26]
obs = [a, b]
chi2, pValue, dof, expected = stats.chi2_contingency(obs)
print 'p-value 3 =', ("{0:.3f}".format(pValue))

print '\nInformal chi squared ='
a = [2, 26]
b = [18, 10]
obs = [a, b]
chi2, pValue, dof, expected = stats.chi2_contingency(obs)
print 'p-value =', ("{0:.3f}".format(pValue))

print '\nRelaxing chi squared ='
a = [4, 24]
b = [18, 10]
obs = [a, b]
chi2, pValue, dof, expected = stats.chi2_contingency(obs)
print 'p-value =', ("{0:.3f}".format(pValue))

print '\nPreferred chi squared ='
a = [16, 12]
b = [12, 16]
obs = [a, b]
chi2, pValue, dof, expected = stats.chi2_contingency(obs)
print 'p-value =', ("{0:.3f}".format(pValue))
```

Website 1

```
import scipy.stats as stats


print '\nLook t-test ='
a = [7,5,6,6,4,5,4,7,6,6,3,3,6,6,6,5,6,3,5,6,2,6,8,4,7,5,1,7]
b = [9,7,9,9,8,8,9,9,8,9,8,8,8,8,7,8,10,8,8,8,8,8,9,8,9,8,7,7]
tStatistic, pValue = stats.ttest_rel(a,b)
print 'p-value =', ("{0:.3f}".format(pValue))

print '\nFeel t-test ='
a = [7,5,6,6,4,5,4,7,6,6,3,3,6,6,6,5,6,3,5,6,2,6,8,4,7,5,1,7]
```

```
b = [9,7,9,9,8,8,9,9,8,9,8,8,8,8,7,8,10,8,8,8,8,8,9,8,9,8,7,7]
tStatistic, pValue = stats.ttest_rel(a,b)
print 'p-value =', ("{0:.3f}".format(pValue))

print '\nNavigation t-test ='
a = [8,3,4,6,2,5,1,6,1,9,5,3,1,6,2,3,7,1,6,7,1,6,6,3,7,2,1,8]
b = [10,10,10,9,8,10,10,9,10,6,9,10,8,9,10,9,10,10,9,10,9,8,10,8,9,8,6,6]
tStatistic, pValue = stats.ttest_rel(a,b)
print 'p-value =', ("{0:.3f}".format(pValue))

print '\nProfessional chi squared ='
a = [0, 28]
b = [24, 4]
obs = [a, b]
chi2, pValue, dof, expected = stats.chi2_contingency(obs)
print 'p-value 3 =', ("{0:.3f}".format(pValue))

print '\nClean chi squared ='
a = [3, 25]
b = [21, 7]
obs = [a, b]
chi2, pValue, dof, expected = stats.chi2_contingency(obs)
print 'p-value =', ("{0:.3f}".format(pValue))

print '\nMessy chi squared ='
a = [13, 15]
b = [0, 28]
obs = [a, b]
chi2, pValue, dof, expected = stats.chi2_contingency(obs)
print 'p-value =', ("{0:.3f}".format(pValue))

print '\nPreferred chi squared ='
a = [1, 27]
b = [27, 1]
obs = [a, b]
chi2, pValue, dof, expected = stats.chi2_contingency(obs)
print 'p-value =', ("{0:.3f}".format(pValue))
```

User Manual

Website 1

This is a single page website with scrolling navigation or the use of the navigation bar at the top of the page for quicker navigation to specific sections.

Within the "What I Do" section the images can create small windows when clicked with additional information regarding the activity and information about the image. Selecting the bottom "x close" button or the top right "x" button will close this smaller window returning you to the rest of the website.

The "About Me" section has some details about myself that can be read for additional information.

Within "Contact Me" a form is available to submit a message with information which can be used to contact yourself. The email address will be checked for basic correctness limiting the option to send the form until it is correct displaying a message to inform you of such an occurrence. In the event that the mail server is not available an error message will be displayed asking for you to try again later.

Finally, in the footer of the page, my most common locations, links to my social media accounts, and my avatar names within video games can be found.

Throughout the website when viewed on a smaller screen an arrow will be present in the bottom right allowing you to return to the top of the page. Similarly, the top left logo will also perform this function regardless of screen size.

Website 2

This is a multi-paged website with several options for navigation, for ease this manual will instruct you based on the always present navigation bar at the top of the page.

To see a general overview of the business scrolling around the first page will give you some idea of what Purple is, where they are located, and the option to get directions via Google Maps.

If you wish to learn more about Purple, using the navigation bar you can select "About" to be directed to a page with more information about Purples roots and key staff members. Alternatively, you can go to the "All Services" page to learn more about the provided services, access this by selecting the "Services" drop down menu and selecting the top item "All Services". Each image and service title will link you to more information regarding that service.

If you wish to get in contact with Purple selecting "Contact" from the navigation bar will take you to the "Contact Us" page where a map is displayed of the location of Purple. Below the map you will find a phone number and email address for contacting Purple during the hours displayed. Alternatively you can send a message using the provided form. The form requests a name, phone number and email address for us to contact you alongside the message you wish to send. The email address will be checked for basic correctness limiting the option to send the form until it is correct displaying a message to inform you of such an occurrence. In the event that the mail server is not available an error message will be displayed asking for you to try again later.

If you have been sent to the website in order to get a form i.e. referral forms, you will find them in the "Downloads" page under the "Other Pages" dropdown menu on the navigation bar. Clicking the image or title of the relevant form will begin the download to your device.

At any time clicking the top left "Purple Professional Services" within the navigation bar will return you to the front page where we began.

App

Once the App is running a brief splash screen will display showing the app name and a paper-based journal background.

You will be greeted with a login/register screen.

Inputting a valid email address and a password at least 5 characters long will allow you to progress to the main screen.

Invalid entries within the login/register page will give a notification of what caused the error close to the error itself i.e. the password entry field for a 3-letter password.